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How do personalized learning programs' instructional designs match gifted students' experiences in using them?

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HOW DO PERSONALIZED LEARNING PROGRAMS' INSTRUCTIONAL DESIGNS MATCH GIFTED STUDENTS' EXPERIENCES IN USING THEM?

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Certification of Authorship

I certify that I am the sole author of this dissertation. Any assistance received in the preparation of this dissertation has been acknowledged and disclosed within it. Any sources utilized, including the use of data, ideas and words, those quoted directly or paraphrased, have been cited. I certify that I have prepared this dissertation according program guidelines as directed.

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ABSTRACT

Personalized learning technology is a quickly spreading and well-funded educational trend that is the focus of much discussion and controversy. The impact of personalized learning tools for reading in the general education population have been widely researched and hotly debated, but there is little research around the success and impact of its use with gifted students. Using a grounded theory methodology, my qualitative research study worked within the theoretical frameworks of critical technology and New Literacy to compare the assumptions and understandings about the reading process applied by the developers of Reading Plus, a personalized learning program for reading, with the experiences of gifted fourth-grade students using it. My research showed that Reading Plus matches the extant researched criteria for quality personalized learning tools for reading development. Overall, the product's features fit with the experiences and learning needs of the students in the study; however, there was some misalignment in the areas of students' motivation, challenge, and academic confidence. Although the student participants comprised a generally homogenous group, their experiences, preferences, and understandings of technology were quite varied.

My key recommendations are that educators and curriculum as well as instructional technology developers should focus on the differences in the experiences, preferences, and abilities of students when building, selecting, and using educational technology tools. The need to more individually and holistically match a personalized learning tool with students is necessary and possible, given the increased adaptability of emerging software and hardware in the educational technology marketplace. In addition, researchers need to look more deeply into the impacts of technology on more diverse learner populations, including gifted students.

Keywords: reading instruction, instructional technology, New Literacy, critical technology theory, Reading Plus, gifted education

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Chapter 1: Introduction

From an early age, my daughter Annabelle has been an expressive talker and enthusiastic reader, taking after her grandfather, a gregarious comparative literature and classics professor who has boundless interest in the world around him. Shortly before her third birthday she began memorizing books and "reading" them back to us, flipping the pages and dictating the stories just as she saw us doing for her. On her third birthday, we presented her with a stack of books, and she proceeded to open Mo Willem's *Time to Pee!* for the first time and read it to us, unsure of some words but generally reading with proper pronunciation and inflection. By kindergarten she was reading chapter books, and by the beginning of third grade the NWEA Measures of Academic Progress (MAP) test placed her at the 13th-grade Lexile level in reading and language usage. As is the case with many gifted students, it was difficult to find reading material that was challenging and captured her interest but was also appropriate for her age, social and emotional level, and knowledge of the world. She found the abundant fairy stories that were written for her age and reading level simplistic and boring. She dove into the Harry Potter series instead but was halted by nightmares about the characters and their battles.

Her school, a PreK-8 gifted institution with small, academically differentiated classes, faces similar challenges in offering curricula and content that are appropriate both in their level of difficulty and in the topics they cover. In language arts classes the students have a wide range of interests and abilities in their reading levels, writing and analytical skills, and comprehension. The diversity of lesson plans and materials required to meet every child's needs are more than teachers can create on their own. To fit that need, the school uses instructional technology tools that provide personalized content, exercises, and assessments, as well as individually targeted motivation and engagement techniques. These tools are considered *personalized learning tools*, a

broad category that encompasses myriad types of individualized content and pedagogy instruments. The 2014 working definition of personalized learning from the Bill and Melinda Gates Foundation covers the broad brushstrokes and is applicable to the intents and focuses of my own research, so I will use it here. Their definition describes personalized learning as a tailored instructional environment that addresses the individual needs, skills, and interests of each student (Boninger et al., 2019).

Personalized learning tools are marketed as a solution to the challenges of a mixed-ability classroom, a way that teachers can reach learners of all aptitudes, abilities, interests, and languages. These "adaptive literacy intervention" products, such as Lexia, ScootPad, Reading Plus, Headsprout, IStation, and Accelerated Reader, assess and benchmark students (Lexia, n.d.; ScootPad, n.d.; Headsprout, n.d.), offer personalized content and exercises to suit the students' needs (ScootPad, n.d.; Lexia, n.d.), notify teachers and families of the students' progress and areas of weakness (Reading Plus, n.d.), and offer supplemental exercises to boost students' aptitudes in those areas (Headsprout, n.d.; Reading Plus n.d.). The tools include titles that may not be available in a typical elementary school library, both fiction and non-fiction and in many languages (Reading A-z, n.d.), broadening the depth and breadth of materials available to educators and students. Many such products offer not only lessons, exercises, assessments, and content, but also focus on the personal motivations of the students, increasing students' motivation and comprehension (Reading Plus, n.d.), fostering a "growth mindset" in their classrooms, and leading the students to perform "considerably higher academically than unmotivated and unengaged peers" (Lexia, n.d.). Reading Plus states that it motivates students by allowing them to suggest content that is of interest to them and providing cross-disciplinary,

grade-appropriate text that "allow[s] students to relate to shared experiences and discover the world around them" (Reading Plus, n.d.).

Personalized instructional technology tools have found enormous success in the educational market and are the recipients of substantial funding from private and corporate investors as well as federal and local policymakers. Schools and districts in the United States spend an estimated $13 billion on educational technology each year (Schaffhauser, 2020). The Obama administration announced the allocation of almost $3 billion in funding from the Federal Communications Commission and technology corporations—including Apple, Microsoft, AT&T, Sprint, and Verizon—for the ConnectEd initiative, which sought to close the technology gap in schools (Enyedy, 2014). Since 2009, the Bill & Melinda Gates Foundation has given more than $300 million to fund personalized learning initiatives, and in 2017 the Chan Zuckerberg Initiative (CZI) announced plans to invest hundreds of millions of dollars in "whole-child personalized learning" that will provide individualized curricula as well as social, emotional, and physical developmental support (Herold, 2017a). That year, the Gates Foundation and CZI jointly funded a $12 million initiative to a Boston-based venture philanthropy organization, New Profit, to fund seven separate organizations within the personalized learning field (Herold, 2017a).

Developers of the most popular personalized learning instructional technology tools for the reading market claim to have millions of customers and decades of expertise. Examples include Renaissance Learning, the owners of Accelerated Reader, which asserts that more than one-third of all U.S. schools have their products ("About us," n.d.), or Reading Plus, which dates back to the 1930s, when it introduced "pioneering research and groundbreaking inventions that have helped millions of students become more fluent readers" ("A history of innovation," n.d.).

Despite their label, personalized reading instruction tools face significant challenges in meeting the needs of every learner. They all rely upon proprietary algorithms that make inferences and interpretations of students' abilities, a design element that is far from perfect. By definition, personalized learning tools support and teach students from a variety of backgrounds and aptitudes. Dual language learners, students with special needs, struggling readers, gifted and talented students, and students who have had significantly different life and educational experiences than the national norm all require content and pedagogy that are customized for their unique experiences and abilities (Delpit, 2006; Adams et al., 2017).

How successful are these tools in providing appropriate and effective curricula to a wide range of learners? The question faces a great deal of controversy and disagreement. The Gates Foundation commissioned the RAND Corporation to carry out a study on the impact of personalized learning programs in reading and mathematics for approximately 11,000 students in 62 foundation-funded, public charter and district schools. The schools in the study were predominantly in urban areas and had a median of 75% students of color and 80% students eligible for free or reduced-price lunch (Pane et al., 2015). The researchers found a majority of schools that used the personalized learning system saw an improvement in student performance in reading over three years, a substantial increase relative to national averages. The growth in achievement levels was greater for lower-level students, and overall the gains were greater in math components than on the reading side and within the elementary grades.

Tamim, Bernard, Borokhovski, Abrami, and Schmid's (2011) second-order meta-analysis of 40 years of research found that the use of technology for instruction in the classroom has a significant, positive impact on student performance, with the average student in an instructional setting with technology performing 12 percentile points above the average student in a classroom

without technology. The authors offered a major caveat cautioning that instructional technology might not be the sole or even main factor for this success; “instruction, pedagogy, teacher effectiveness, subject matter, age level, [and] fidelity of technology implementation” have an impact of indeterminate importance as well (Tamim et al., 2011, p. 17). Enyedy (2014) echoes this uncertainty, arguing that there is little evidence that personalized instruction overall is effective, largely because the huge variety in types and quality of tools, as well as the widely divergent levels of success and methods for their implementation in the classroom, make it impossible to meaningfully evaluate them.

Critics of personalized learning include teachers, parents, students, and administrators who offer a wide range of criticisms and concerns about the practice. Benjamin Herold, who covers the topic of personalized learning for Education Week, paints a portrait of personalized learning as a failing initiative that is wasting hundreds of millions of dollars and prompting condemnations from researchers, education experts, parents, and activists who see personalized learning as an Orwellian plot to replace teachers with technology (Herold, 2017b). This fear of a loss of control and a displacement of the human workforce with technology tools is shared in many areas of the education world (Boninger et al., 2019). The National Education Association, the largest teachers’ union with more than 3 million members, published an article noting the changing place of the teacher within the classroom because of personalized learning. The association received fierce backlash from teachers who felt that the article was endorsing their replacement and supporting a movement by Silicon Valley to reduce the teaching force and diminish the power of the teachers’ union (Herold, 2017b).

Despite their perceived shortcomings, personalized learning programs offer the promise of a solution for a particular student population and its specialized curricular challenges: gifted

students who, like Annabelle, often face mismatches between their reading abilities and their intellectual or social and emotional levels. Gifted students also differ from their non-gifted peers in terms of their learning motivation and engagement (Reis, n.d.). The research regarding the efficacy of personalized learning with gifted students in particular is limited, but my personal experience has given me some insights into those challenges.

In the spring of third grade, Annabelle came home full of questions about a story that the reading software program in her language arts class had assigned her to read. She explained to me that it was a story about a man named Gregor who wakes up as a cockroach, and his family is very angry with him. Annabelle was mystified by key aspects of the story: Why did Gregor wake up as a "monstrous vermin"? Why was his father trying to kill him? Why did his sister turn against him? What did the ending mean? She did not understand much beyond the literal interpretation of the short story and did not pass the requisite 80% of the comprehension questions, thus failing the unit and having to start a new collection over from the beginning. There was no follow-up explanation or scaffolding to help her understand what she had read.

Why had the software assigned her content that was a mismatch to her educational experiences and abilities? The answer was in the software's algorithm, which had benchmarked her reading ability at a 13th-grade Lexile level and had assigned her a piece that was appropriate to that cognitive and analytical ability level: Kafka's novella *The Metamorphosis.* Further, the reading pacing test set her reading speed at 356 words per minute and used a guided reading box that set her pace at that speed, allowing her to view only a few words at a time and preventing her from looking forward or backward at the text. Most of the individual words of the story were familiar to her, and, as a result, the software's assumption was that she could understand the sentences that comprised them and a story composed from those sentences. The software gave

her clues to the words' meanings as a form of scaffolding, but it did not offer her schema activation or another pre-reading background knowledge building activity. Likewise, the software failed to help her understand the complex themes of the story, which have been discussed and debated for a century and were all far beyond her comprehension (e.g., psychological interpretations (Bowers, 1980, and Sweeney, 1990); religious allegories and sociological studies (Bloom, 2008); and feminist interpretations (Straus, 1989). Even as a gifted child, Annabelle's interpretations and questions were simple and literal, appropriate to the knowledge level and experiences of a third grader.

Examples such as Annabelle's, combined with the prevalence of new products and the growing controversies surrounding personalized learning's costs and effects on student reading achievement, indicate the need for further examination of the roles and influences that personalized learning tools have on students' learning outcomes. Two theoretical frameworks are helpful in this analysis, providing a lens to look at how the experience of learning to read has changed through technology and what adaptations need to be made to take those changes into account. First, critical technology theory examines the impact of technology on people at the individual, educational, and global levels, addressing questions around appropriate use, accessibility, and impact. Recent critical technology theorists advocate for conducting widespread research into reexamining assumptions and understandings around how and why technology is deployed in schools (Bigum et al., 2015; Johnson, 2015). As they note, there is still much to learn about what specifically influences teachers and other education professionals to use technology-based instructional tools. Second, New Literacy theory looks at how the processes of reading—as well as the teaching and learning of reading—have changed with the proliferation of digital content and delivery (Leu et al., 2014). New Literacy theorists argue that

since the relationship between the reader and the text can be developed in different, additional ways through the aid or mediation of technology versus print (e.g., text-embedded hyperlinks to videos or definitions), additional research is needed to understand not only the advantages of technology-based enhancements but also any potentially detrimental effects on comprehension (see, for example, Dalton & Rose, 2014; Leu et al., 2011; Leu et al., 2017).

Given the substantial investment in instructional technology and personalized learning tools, their ubiquity in schools, and the enormous significance of effective reading instruction in a child's life, it is important to closely examine developers' goals and assumptions in building personalized learning technology programs. As a subset of the student population, gifted students are almost entirely left out of the examination of the impact and efficacy of instructional technology for reading. Therefore, an important goal within this research is gaining a better understanding of how the gifted student population perceive their actual experiences with these learning tools. My study addresses the research question, *How do personalized learning programs' instructional designs match gifted students' experiences in using them?* My sub-questions are:

- What assumptions about how the reading process works at different developmental stages do software developers make in building personalized learning programs, in terms of the reading process, student abilities, motivation, and preferred types of engagement?
- What do gifted students think about their experiences with personalized learning software, in terms of whether it aligns with how they prefer to learn and engage with instructional technology?
- How do the developers' assumptions and understandings match the students' self-reported reflections on their experiences using personalized learning software?

In the literature review that follows, I highlight the relevant research with reference to the use of personalized reading instructional technology tools for gifted students in grades 2-4. My specific aims are to a) provide a brief summary of the theories and processes of reading; b) give an overview of personalized instructional technology for reading in early elementary education; c) summarize the two key theoretical frameworks that guide my study design, New Literacy theory and critical technology theory, as they relate to instructional technology for reading; d) examine research into gifted students' motivation and engagement, specifically as they are related to instructional technology; and e) summarize extant analyses of and recommendations for best practices in using technology for reading instruction.

My methodological approach is a grounded theory study. I first solicited the research, understandings, and algorithms that one particular instructional technology software program used to create their reading program for upper elementary students, and then I solicited the reflective experiences of fourth-grade gifted students who used that software.

Definitions

To narrow the focus of this research, I have used Chall's (1983) stages of reading to define the typical aptitudes and abilities of the readers that are the focus of this paper. I am focusing on Chall's Stage 2, in which students gain ability and confidence in decoding, identifying individual words, and becoming automatic in reading familiar texts. This stage is a vital transition period for students to gain fluency with text and be able to move on to content subjects and informational reading—going from "learning to read" to "reading to learn" (Chall, 1983, p. 21). Students typically reach Stage 2 at ages 7 or 8, or grades 2 and 3, and researchers argue that students who are not able to read proficiently by the fourth grade have not been able to successfully move from Stage 2 to Stage 3 (Little et al., 2017), are unlikely to catch up later

(Forzani & Leu, 2012), and in fact are less likely to reach overall reading proficiency (Ingebrand & Connor, 2017). This is also the point at which students face an increase in textual difficulty, and teachers observe a resulting decline in students' motivation and success (Moser et al., 2017).

I also narrowed my focus within the broad process of literacy and language learning to examine only the components of reading comprehension, which include the skills and strategies for comprehending texts. This does not include the broader components of literacy, which incorporate writing and oral comprehension. When using the term *instructional technology tools,* I am including websites, apps, programs, and other digital educational materials. The instructional technology tools that provide individualized content and pedagogy are broadly labeled "personalized instruction," and focus on customizing the "pace, order, location, and content of a lesson uniquely for each student" (Enyedy, 2014, p. 3).

Personalized instruction falls into three broad categories: adaptive learning systems, which assess students within the instruction and then direct them to leveled and appropriate content and exercises; intelligent tutoring systems, which analyze students' problem-solving abilities and provide continuous, contextualized feedback and adaptation of the exercises; and educational games (Enyedy, 2014). For the purpose of this research, I am focusing on adaptive learning systems and intelligent tutoring systems, but not educational games.

The National Association for Gifted Children defines gifted children as those who are "significantly above the norm" in domains that include intelligence, creativity, artistic, leadership, or specific academic fields (NAGC, n.d.). The cutoff for giftedness is generally the top 2 to 5% of students on standardized assessments or IQ tests (Dai, 2010), but many educators and administrators recommend widening that to the top 10%, using a broader array of assessments beyond standardized academic tests and a local norming group instead of a national

one (Peters & Engerrand, 2016). Other methods of identification include relying on universal screening more than teacher and parent referrals/nominations (Lakin, 2016) and using multiple assessment methods, including portfolios that illustrate students' creativity and critical thinking skills, dynamic assessments, performance tasks and observations of problem-solving skills (Zhbanova et al., 2013), and nonverbal tests (Giessman et al., 2013). The term *gifted and talented* is often used interchangeably with the term *gifted*, and I do so as well here.

Assessments—formative and summative—are a vital part of the process of reading instruction. Both teachers and the instructional tools must assess the students at the beginning and end of the learning process, as well as checking in along the way with formal or informal assessments to check that the content and pedagogy is correctly tailored to the students and the students are progressing as expected. Shortcomings and challenges regarding assessments are a key piece of the discussion around the success or failure of reading instruction. However, the specific assumptions and algorithms that are used in assessing students are complex and highly complicated; discussing their use and best practices is beyond the scope of this paper.

Chapter 2: Literature Review

In my examination of relevant literature, I will review the applicable research in three key areas: reading instruction; personalized learning and instructional technology tools; and gifted education, all at the early and middle elementary (i.e. grades 2-4) level. My goal is to examine the extant literature in these three discrete areas and identify any areas in which the research overlaps, looking at such questions as how gifted students work with instructional technology tools and how personalized tools for reading instruction are built. In this section I will: (a) provide a brief summary of the theories and processes of reading; (b) give an overview of personalized instructional technology for reading in early elementary education; (c) summarize the two key theoretical frameworks that guide my study design, New Literacy theory and critical technology theory, as they relate to instructional technology for reading; (d) examine research into gifted students' motivation and engagement; and (e) summarize extant analyses of and recommendations for best practices in using technology for reading instruction.

Reading Process Theories

The literature about reading process theories covers a wide range of themes and constructs about how the act of reading occurs. Theories vary from ones that focus upon the cognitive and linguistic processes to those that focus upon external influences, educational experiences, and sociocultural impacts, as well as the steps and stages of learning to read (Chall, 1983). Yang et al. (2018) summarized 10 major reading theories that were identified by the International Literacy Association as being the most influential theories from the previous 20 years. These theories are helpful in placing the reading process within two theoretical frameworks of this research. As illustrated in Table 1, the 10 theories can be assembled along a spectrum, with those that are primarily focused on individual cognitive and linguistic processes

at one end and those that are heavily influenced by the readers' sociocultural and political experiences and beliefs at the other; the latter has multiple parallels to critical technology theory.

Table 1

Spectrum of Reading Process Theories

Focus on cognitive and linguistic processes	⟷	Focus on sociocultural and political experiences and beliefs
Dual-coding theory	Schema theory	Reading motivation theory
Information/cognitive processing theory	Psycholinguistic theory	Social constructionism and sociocultural theory
Structuralist theory		Sociocognitive theory
		Transactional theory (Rosenblatt)
		Critical literacy theory

Three theories fall into the broad area of cognitive functioning and processes: dual-coding theory, which examines the verbal and non-verbal effects of input on memory and reading; information/cognitive processing theory, which examines the mental processes of reading, such as Gough's bottom-up/outside-in model, the top-down model, and Rumelhart's interactive models (Morrison & Wilcox, 2010); and structuralist theory, which looks at print perception in such areas as reaction time and reading speed (Yang et al., 2018).

In the middle of the spectrum of the ten theories are two theories: schema theory, which looks at how readers build and maintain understandings of the world that they access in order to comprehend the text; and psycholinguistic theory, in which readers guess and infer to predict and make meanings from the text. Because a reader's experience with a text is unique and shaped by their own experiences, Yang et al. (2018) see both of these theories as constructivist, stressing the active role of readers in the process.

On the other end of the spectrum, five theories are more heavily influenced by social, cultural, and political factors. Reading motivation theory looks at the roles of intrinsic and extrinsic motivation, social motivation, and self-efficacy in the reading process (Wigfield et al., 2016). The social constructionism and sociocultural perspective focuses on the role of interactions, specifically teachers' roles in the process of learning to read, citing Vygotsky's (1978) theory of the zone of proximal development (ZPD) (Selepe & Moll, 2016). Sociocognitive theory focuses on a reader's social and cultural contexts as well as the teacher's role (Yang et al., 2018), and Rosenblatt's (1993) transactional theory sees the process of reading as a highly individual interaction between the reader and the text that is shaped by the reader's experiences and contexts. Finally, critical literacy theory broadly looks at the influences of social and political factors on the reading process with the goal of highlighting social justice issues and marginalized populations (Yang et al., 2018).

Yang et al. (2018) found that the sociocultural perspective was the dominant theory addressed in 33.3% of the articles they examined. The next most dominant theories were reading motivation theory (30.1%), social constructionism (27.8%), and dual-coding theory (25.0%). The sociocultural perspective, social constructionism, and reading motivation theories fit well within the critical technology theory lens, and the dual-coding theory fits well within the New Literacy theory, which will be discussed in more depth below.

Reading Development Theory and Instruction

Research and theory regarding how reading skill emerges and the developmental implications for instruction across the stages of reading acquisition have varied over the centuries (Chall, 1983). Current theorists agree on the need for reading instruction to ensure all children can comprehend what they read and become increasingly fluent while reading.

Researchers focused on delineating how reading instruction should shift; as children grow they tend to view the reading process as a dynamic act involving four main components: a pre-reading process, a step of decoding and analyzing words, a step of recognizing individual words (vocabulary), and a final step of fluently understanding what has been read altogether: (comprehension) (Morrison & Wilcox, 2013). Although researchers vary in theorizing which particular subskills need more or less attention at the different developmental reading levels, there is general consensus about the skills to be taught for each component, as the following sections describe.

Prereading

In the preparatory stage for reading, students need to be guided or otherwise encouraged to think about what they might already know about a text—their schemata—based on the selection's title, illustrations, or other background-prompting information they are provided. Anderson and Hite (2010), Gill (2008), McKeown et al. (2009), and Morrison and Wilcox (2013) note other important prereading activities, including upgrading students' background knowledge for an unknown text through pre-teaching foundational concepts upon which the text relies; fostering students in developing and articulating a purpose for reading; and directly teaching them relevant vocabulary contained within the selection in their contexts. Researchers who examine the prereading stage through a critical technology or schema-theory lens note the importance of reading as teachers to build upon their students' sociocultural backgrounds and previous educational experiences in developing prereading activities, given how these directly influence how children activate their schemata and how they approach comprehending a new text during the pre-reading process (New literacies and 21st-century technologies: A position statement of the International Reading Association, 2009; Leu et al., 2015; Leu et al., 2017).

Decoding and Word Analysis

As students begin reading texts, they analyze and decode words through a variety of strategies. Many early readers rely heavily upon their phonemic and phonological awareness in applying their phonics knowledge, seeking familiar patterns of sound-symbol correspondence (Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction, n.d.). As early readers progress in developing strategies, they focus more on looking for patterns in words that hold meaning: prefixes, suffixes, and roots (Morrison & Wilcox, 2013). Any deficiency or relative immaturity in these word analysis strategies will significantly hinder students' reading comprehension (Snow, 2002), no matter their age or stage of reading development.

Word Recognition

The act of reading requires automatic word recognition skills, "the ability to identify words so quickly that [readers] have sufficient cognitive resources available to construct meaning from text" (Moser et al., 2017, p. 365). Word recognition ability is one of the major predictors of intermediate-grade students' subsequent reading comprehension (Moser et al., 2017). Students cannot achieve fluency until they have achieved accurate and effortless word recognition (Bashir & Hook, 2009). A pre-requisite for word recognition is vocabulary and word knowledge (Snow, 2002).

Beck et al. (2013) conceptualize vocabulary stores as being of three different types, or tiers. Tier One comprises basic words that are used often in conversation and therefore rarely need to be directly taught in school (e.g., cat, sun, like). Tier Two comprises high-utility words that are not often used in conversation and require instruction within school, especially since their meanings are often contextually bound (e.g., analyze, system). Tier Three words are

specialized words used in specific circumstances, often within the social sciences and sciences. Critical technology theory highlights the fact that differences in conversational words and native languages will have an impact on how many words—and which words—a student will know in English. Since students at all stages of reading development are fairly dependent upon teachers and other adults when learning new words, reading instruction programs of all types devote significant attention to providing curriculum and lessons that teach vocabulary in ways to develop breadth as well as depth (Morrison & Wilcox, 2013).

Comprehension

Pearson and Cervetti (2015) trace the evolution of comprehension theory from the text-centric period of pre-1965 to the current concentration on construction-integration models such as Gough and Tunmer's (1986) Simple View of Reading (SVR). The SVR model posits that reading comprehension develops as both word analysis skills (e.g., decoding) and language comprehension knowledge (e.g., vocabulary, sense of grammar syntax) mature. Snow (2002) notes seven variables that influence the achievement of reading comprehension, including knowledge of vocabulary and linguistic skills; non-linguistic cognitive skills and strategies, including "attention, visualization, inferencing, reasoning, critical analysis, [and] working memory," motivation and confidence; knowledge of discourses and domains, and engagement and motivation (p. 22). Oakhill and Cain (2017) focus on three higher-level skills related to comprehension and meaning-making: inference-making, self-monitoring of comprehension, and understanding of text structure (p. 50).

The RAND Reading Study Group defined reading comprehension as "a process of simultaneously extracting and constructing meaning through interaction and involvement with written language" (Snow, 2002, p. 11). Glenberg et al. (2017) differentiate between the most

common theories of comprehension that call for an understanding of the meaning of words within the context of the syntax or propositional analysis of the text, with embodied approaches to comprehension that argue that it is a simulation process that draws on "neural systems of action, perception, and emotion" (p. 269). In this theory, readers imagine a visual image of the words on the page. LeVasseur et al. (2008) tested varying print layouts, comparing cued text (text printed with spaces between the phrases and the ends of lines marking the end of clauses), standard print layouts, and word lists, and they found that gains in phrasal reading for students who used cued text were "twice and three times as large as after training on standard text and word lists, respectively" (p. 220). The considerations of New Literacies theories, specifically the variations in text layout and appearance, are highly relevant to such analyses, as the layout and appearance of texts and accompanying images vary widely depending upon the device used, from cell phones and iPads to tablets and computers. Readers can adjust the font, size, and even color of the texts within many reading programs, and there are tools to navigate the text, embedded links, and supplementary digital content such as video and audio clips. This variation in appearance, access, and content ensures that every reader will have a different experience with a piece of text in a digital format than with the print version, and experiences often differ among digital-format readers.

Fluency

Bashir and Hook (2009) offer a definition of fluency, the rapid and highly accurate reading of texts that results from applying "orthographic, phonological, and semantic processes" without conscious attention to decoding and other mechanics of reading (p. 197). Fluency is also indicated by the appropriate use of stress, intonation, phrasing, and prosodic features during reading (LeVasseur et al., 2008, p. 206), and prepares the reader to transition their attention from

"sublexical (e.g., phonemes) to higher language and cognitive processes underlying comprehension" (p. 198). Fluency is generally achieved by the time readers reach Stage 3 (Little et al., 2017, p. 934), though Kim (2015) notes there is an important difference between text-reading fluency and word-reading fluency, and their relationships to reading comprehension, which changes as children grow. In earlier stages of reading, when decoding is the primary focus, word-reading fluency is more influential in comprehension, but in later stages of reading, text-reading fluency is more important (p. 460). LeVasseur et al. (2008) note that there is a lack of agreement on the best methods and materials for gaining fluency, but repeated readings of the same passage—either assisted or unassisted—to increase comprehension and speed was shown in studies in the 1990s to be more effective than individual free reading.

Reading Skills and Strategies

Afflerbach et al. (2008) define reading comprehension strategies as "deliberate, goal-directed attempts to control and modify the reader's efforts to decode text, understand words, and construct meanings of text" (p. 368). They distinguish reading strategies from reading skills, which they argue are characterized by their degree of automaticity in application. That is, skills are vital in order to comprehend texts, but they are executed without awareness or intentional control and decision-making, unlike strategies. One hallmark of a proficient reader at any developmental stage is the ability to use the necessary skills in the strategic, or mindful, processing of a text.

Within the literature, there is disagreement about which and how many reading strategies are essential for success and whether focusing primarily on teaching reading strategies is the best method. Crossley and McNamara (2017) argue that explicitly teaching reading strategies is crucial to the process of learning to read because they help students separate the process of

reading into manageable tasks, which require particular heuristics for comprehension. They note how struggling or less-mature readers are helped more by reading strategies instruction than are their more able peers, especially when these students do not possess sufficient vocabulary or domain knowledge (Crossley & McNamara, 2017). Willingham (2006), however, minimizes the importance of teaching reading strategies, arguing that while it is a "low-cost way to give developing readers a boost…it should be a small part of a teacher's job" (n.p.). He contends that skills instruction should not be given a higher priority than building background knowledge and vocabulary.

Variations in Theorizing Strategy Types

The research literature offers a number of theoretical frameworks about reading comprehension strategies for teachers and curriculum developers to consider. Graesser (2007) argues there are three essential types of strategies involved in the comprehension process: construction-integration (CI), constructionist, and embodied cognition. McNamara and Magliano (2009) describe, compare, and evaluate seven models of reading comprehension, including ones posited by Graesser (2007): construction–integration (CI), structure-building, resonance, event-indexing, causal network, constructionist, and landscape. They note that CI was the earliest model and is still considered the most complete and well-formulated. They conclude that current models are not contradictory but rather complementary, with no single model capable of covering all reading situations. And, even with the range of models available, they are too limited in capturing all the nuances involved in understanding what is read. Several models, including the structure-building model, which examines comprehension within any medium, and the constructionist model, which argues that readers construct models to understand the text based on local and global coherence and knowledge available to them (McNamara & Magliano,

2009), include aspects of critical technology and New Literacy theories. These comprehension strategy theories incorporate the roles of readers' backgrounds, viewpoints, and experiences in the text processing and accommodate the visual processing changes brought by the introduction of technology to reading instruction and modes of presenting texts.

McKeown et al. (2009) conducted a two-year study with fifth-graders in a low-performing district in which they compared the efficacy of content-based instructional strategies, which had students focus on the content of the texts and build comprehension through discussion, with a strategies approach, which focused on teaching the students comprehension procedures, including summarizing, making inferences, and generating and using questions. Students' narrative recall, amount, and length of responses were stronger in the content group. The authors' overall conclusion was that making connections among ideas is of the greatest importance; focusing more so on deciding which strategies to use at any given moment while reading a text might distract students from the content. Therefore, McKeown et al. (2009) contend that providing content instruction is more likely to support students in fully comprehending what they read, as Willingham (2006) also contends.

Reading in the Digital Space: Theoretical Frameworks

Technology has changed the fundamental processes and definitions of reading, from how readers approach texts to their ability to interact with and even manipulate them. This section will examine in more depth the changes that technology has brought to the processes of selecting, accessing, and using texts through the frameworks of New Literacy theory and critical technology theory. These theories help us understand the experiences of Annabelle and other gifted students in their uses of instructional technology for reading and how their learning challenges in a digital space can be anticipated and addressed, if not prevented.

New Literacy theorists argue that the content, pace, and experiences of readers differ depending upon whether text is accessed in a print or an electronic form (Yang et al., 2018). Our 21st-century reliance upon reading content in digital forms has complicated both agreement upon the definition of the reading process as well as which skills, strategies, and pedagogies are most necessary for fostering comprehension. Learning theorists, however, have not yet reached consensus about the impact of technology on the reading process, however. Willingham (2017) argues that "the changes the digital revolution has brought to reading are actually quite modest," with the preponderance of studies indicating a limited positive effect on students' reading outcomes (Willingham, 2017, p. 160). But others, such as Coiro (2012), argue that technology has radically and fundamentally changed the process of reading itself: "It used to be that there was a pre-reading, the reading itself, and the evaluation at the end of your chapter or at the end of a book. Now that process happens repeatedly in about 4 seconds: I choose a link. I decide whether I want to be here/I don't want to be here, and then, where should I go next?" (Korbey, 2018). The existence of increased flexibility and options during interactions with digital texts are undeniable, but the question remains of what impact those have on the reader's experience.

The term multiliteracies was coined in 1996 by a group of literacy educators, linguists, and researchers called the New London Group as a culmination of a two-year project examining the multiple dimensions of literacies, including the multilingual and the multimodal (Cope & Kalantzis, 2009; Serafini & Gee, 2017). Researchers such as Mangen and van der Weel (2016) examine the impact of multiliteracies on the reading process, arguing that changes to the "mediascape" have brought new questions and definitions to such fundamental terms as text and reading, reframing the idea of literacy as a plural construct. The authors present a new framework for reading research that incorporates an empirical theoretical-methodological

approach that looks at the interplay among ergonomics, attention, perception, variations in cognitive and emotional processing, and the differences in experiences of reading multiple genres and for multiple purposes.

Leu's (2009, 2011, 2014) dual-level New Literacies theory provides a research-based framework for considering the breadth of shifting influences on reading process theory and instruction resulting from the introduction of technology-based content and tools. New Literacies theory argues that there are emerging, common findings about what most influences which particular reading skills and strategies that are needed for reading comprehension today. These influences include but are not limited to: the Internet and related technologies, which require new, dynamic, and deictic literacies for learning and communicating across what are now global communities; social practices (e.g., social media, texting) for communicating and learning; and the essential nature of online texts, which force the reader into problem-solving situations in order to navigate through them (Leu et al., 2014). Another level of New Literacies theory—the lowercase *new literacies* theory—posits how specific types of technology and their social practices are formulated as well as how they morph through discovery, innovation, and introduction of new designs. Leu et al.'s (2014) theorization highlights the need for teachers to be knowledgeable about the reading processing demands certain technologies place upon students as well as how those particular technologies are part of the larger landscape of ever-evolving digital literacy tools continuously affecting the learning standards upon which their curriculum and instruction are based.

New Literacy and multiliteracy theories fit neatly with Rosenblatt's (1993) transactional model of reading, which posits that each reader's experience with a text is unique and deeply intertwined with the reader's previous experiences and viewpoints. I include this long, verbatim

quote because it clearly and eloquently defines the individual experiences of reading and engaging with a text:

> No one else can read a literary work for us. The benefits of literature can emerge only from creative activity on the part of the reader himself. He responds to the little black marks on the page or to the sounds of the words in his ear and he makes something of them. The verbal symbols enable him to draw on his past experiences with what the words point to in life and literature. The text presents these words in a new and unique pattern. Out of these he is enabled actually to mold a new experience, the literary work. (Rosenblatt, 2005, p. 2)

Burnett (2010) similarly argues that personalized reading programs make students passive learners, and the images and text of the instructional technology texts reflect social constructions of reality and as a result, interact with and influence children's engagement in different ways. As a result, he argues, any analysis of instructional technology should position the students and technology as actants and consider the mutual impact and influence that both have (Burnett, 2010). In a related argument, Leu et al. (2017) argue that new technologies enable new ways of creating, accessing, understanding, and sharing content. The fact that students increasingly know different literacies will change effective teaching and learning practices by distributing knowledge among students and prompting new social practices and learning strategies that allow for more sharing of information among students.

The second theoretical lens that I will apply to this study is critical technology theory, which highlights the political, socioeconomic, and cultural factors that influence reading instruction and learning processes, questioning the differences of defining literacy and examining dominant, marginalized, and resistant literacies (Street, 2003; Selwyn, 2011; Selwyn, 2013).

Applying critical technology theory to understanding students who struggle with technology-based texts yields insights not otherwise obvious or possible. For example, dual language learners might not have the experience and fluency in English to be able to compensate for the inadequacies of computer pronunciations and inflection in computer read-aloud features that can be challenging to understand. In other cases, students' lack of exposure or access to technology will impede their ability to use it as quickly and efficiently as their peers who have much more exposure and access. Students' lack of exposure, access, and training with technology has a direct impact on their performances on high-stakes achievement tests that are a key component of their academic experiences.

A key focus of critical technology theory is seeing the use of technology as an overtly political act; as Apple (2013) and Selwyn (2013) argue:

> Educational technology has been found to be entwined with wider societal and economic shifts that have little to do with the straightforward connections between technology, teaching and learning that usually inform discussions in this area. Instead, educational technology should be understood as an integral part of broader efforts to sustain the dominant neo-liberal project that informs so much of contemporary "global society." (Selwyn, 2013, p. 148)

In this research, I will focus less on the global political impact of technology as a political tool; instead I will use a narrower focus within the educational setting that questions and problematize the reasons behind the use of technology in schools, the assumptions and claims used around technology, and the impact of technology on the field of education.

To start the conversation about technology in education, Selwyn (2011) looks toward influences such as the organizational concerns of administrators, the lived experiences of both

educators and students, and commercial and private interests on the creation, selection and use of instructional technology. Looking at the use of instructional technology for reading through that lens produces questions relevant to this study that include: What drives the creation and implementation of instructional technology tools? What are the impacts of technology within the educational setting, from the individual to the group levels, in such areas as how students master reading skills and strategies; how quickly and successfully they obtain reading fluency; how well they achieve comprehension?

Reading in the Digital Space: An Overview

Reading instruction and learning in the digital space differ in important ways from the methods and experiences of reading with print materials. Technology is required and desired—by educators, students, families, and policy-makers—making the analysis of and conversations around technology vital. Within the setting of reading instruction, technology serves as one of a variety of methods and pedagogical supports for at-level and above-level students; technology also provides an additional support tool for below-level students and students with special needs, reducing learning barriers around decoding and fluency (Dalton & Strangman, 2013). Technology is not just a helpful addition to reading instruction, however; it is a recommended addition by many professional associations, including the International Reading Association (now the International Literacy Association; New literacies and 21st-century technologies: A position statement of the International Reading Association, 2009) and the National Council of Teachers of English (Position statement: Beliefs for integrating technology into the English Language Arts classroom, 2018), as well as a fundamental part of the Common Core Learning Standards, which include technology proficiency in their reading and writing standards across the ages and stages. This section will provide an overview of how technology is used in reading

instruction and will offer some specific examples of reading instruction programs used for Stage 2 readers (typically, children in grades 3-4).

Tools and Uses of Instructional Technology in Reading.

In their review of 164 articles published in *The Reading Teacher* and the *Journal of Adolescent and Adult Literacy* between 2004 and 2015, Yang et al. (2018) found that the primary functions of technology in reading instruction were to enhance student engagement and motivation (51.4%), engage students in multimodal learning (34.7%), and promote collaboration (22.2%), although the three categories were not mutually exclusive.

Technology-based support and software features built into digital reading instruction programs typically include text-to-speech functionality; voice recognition; clickable vocabulary definitions and background information (usually via embedded dictionaries and hyperlinks); informational videos that expand upon key ideas or provide practice, accessed through hyperlinks; strategic reading prompts and model responses; and study tools such as highlighters and annotation (Brann et al., 2014; Dalton & Rose, 2014). Matteson (2016) notes that the use of e-books in the classroom offers such benefits as alleviating students' concerns about being judged for the level or selection of their books and allowing students to change the fonts, sizes, and print margins for maximum accessibility and ease of use. Block et al. (2009) note that some researchers hypothesize that a lack of high-quality, increasingly more complex books in schools is limiting or otherwise having a negative effect on students' reading comprehension levels. It could be that without being able to provide students a choice of texts, their reading motivation and engagement—whether they struggle with reading or not—suffers. A lack of books for the wide range of reading ability found in the typical classroom can be addressed through the use of

software programs that provide multiple copies of a broad range of texts, as well as texts in multiple languages.

Along the same lines, Yang et al. (2018) cite Dierking (2015) who argues that the more interactive reading instruction possible with digital programs could appeal to reluctant readers and motivate them to engage more actively with texts. Yang et al. (2018) also argue that collaborative reading of texts and discussions via online discussion boards promote student engagement; enhance understanding of the texts through group discussions and differing peer opinions; and give students a voice for discussing the text with peers, with more opportunities for participation than traditional in-class discussions. Reading and responding to what has been read in the digital space provides students with wider opportunities to immerse themselves in processing texts, compared to how traditional print texts are typically used in schools.

Reading Instruction Products and Programs

Many different adaptive literacy instruction products are now available for Stage 2 readers. Among the most commonly used in schools are such personalized learning tools as Reading Plus, Lexia's Core5 Reading, Headsprout, and Accelerated Reader. Lexia describes its Core5 Reading product as supporting development in six main areas of reading acquisition and development: phonological awareness, phonics, structural analysis, automaticity, and vocabulary acquisition. Lexia emphasizes how its product creates personalized experiences for students through continuously adaptive placement in appropriate texts. It provides scaffolded activities that rely upon using higher-order thinking skills across increasingly complex narrative and informational texts (Lexia, n.d.). Headsprout similarly advertises an adaptive, individualized reading solution that fosters phonemic awareness, phonics, fluency, vocabulary, and beginning comprehension development in order to help students master the "four primary components of

reading comprehension: finding facts, making inferences, identifying themes, and learning vocabulary in context" (Headsprout, n.d.). It, too, uses assessments to determine the specific, differentiated materials needed by each student, as well as the foci of the continuous instructional sequence and scaffolded instruction. Accelerated Reader (n.d.) markets its product's unique design for ensuring that all students work on personalized learning goals through ongoing reading, writing, and quizzes that are tracked for teachers through a class summary reading dashboard.

Examples of more recently published or in-development adaptive learning systems for students in grades 3 and up include Learning Ovation's Assessment-to-Instruction (A2i), which benchmarks K-3 students' abilities in vocabulary, decoding, and comprehension, then providing teachers with content, planning, and instructional tools that the publisher claims will ensure every student, regardless of initial achievement level, gains a year's worth of academic progress during the school year (Ingebrand & Connor, 2017). A researched and field-tested program under continued development is the Intelligent Tutoring of the Structure Strategy (ITSS), an adaptive system that provides web-based reading comprehension strategy lessons of five types: comparison, problem and solution, cause and effect, sequence, and description for students in grades 4-8 (Meyer & Wijekumar, 2017). DSCoVAR is another individualized tutoring system designed for intermediate-level readers that teaches Tier 2 words within brief contexts (Frishkoff et al., 2017).

Extant Analyses of Instructional Technology Tools for Reading

In looking at the impact of technology in the school setting, it is helpful to review the research to date on specific tools and programs for reading instruction, both generally and with specific tools. Jamshidifarsani et al. (2019) created a meta-analysis of extant research on

"technology-based or technology-assisted reading interventions for elementary grades, between 2000 and 2017" (p. 427), comprising 42 articles that evaluated 32 programs. The authors found that there are few programs focused on fluency or vocabulary interventions. The authors did not include coverage of Reading Plus.

The literature can be broadly divided into four categories of research: formats, including comparisons of print and digital content; features, such as text-to-speech, hyperlinks, and instructional videos; classifications by purpose or focus—for example, technology that focuses on strategies versus content; and analyses of individual technology-based programs.

Formats

The literature on the effects of various formats on reading at Stage 2 is limited. The field is not yet at a point of consensus, though findings are useful in analyzing recent and emerging products. Researchers at the Joan Ganz Cooney Center at Sesame Workshop conducted a study (Chiong et al., 2012) in which parents read a print book and an e-book with their three- to six-year-old children (a slightly younger group than this paper is examining). They compared the adult-child interactions during each experience and found that print books were more beneficial for helping children label objects, answer questions regarding the text, and discuss the content of the stories and texts through their own experiences through co-reading. However, the researchers found that ebooks were more beneficial for engaging children and prompting developmentally appropriate physical interaction. The Cooney Center's researchers concluded that while engaging, e-books' multimedia features should be designed to focus on enhancing the experience of reading, building comprehension and apprehension of the texts' themes, rather than distracting children from making meaning of what is presented in the text and illustrations (Chiong et al., 2012). A study by Margolin et al. (2013) compared how a text's format—paper, computers, or e-

readers—affected students' comprehension of narrative or expository text. They found no significant differences among three different presentation modes and did not find that students were changing their reading behaviors when they read texts in different formats (Margolin et al., 2013). Neither study examined any effect of either the students' educational backgrounds or previous exposures to the reading technology tools used. Future research in this area would benefit from using a critical technology lens to measure the effects of formats on students' success when taking into account socioeconomic factors, English language reading ability, and other sociocultural contexts.

Features

The research on the features included in instructional technology tools, such as text-to-speech, hyperlinks, and instructional videos, shows mixed benefits of such additions. Two studies examined the efficacy and impact of specific features on students' reading achievement. Dalton and Rose (2014) found that read-aloud tools helped younger students' work in learning word recognition and fluency skills. However, although multiple research studies showed that text-to-speech tools assist in providing immediate access to the text at hand, they found no long-term boost in comprehension. Takacs et al. (2015) examined data from 2,147 children in 43 studies that looked at the effects of technology-enhanced stories on young children's literacy development when compared to listening to stories in more traditional settings such as storybook read-alouds. The literature they reviewed supported the argument that multimedia features such as animated pictures, music, and sound effects were beneficial, but interactive elements such as hotspots, games, and dictionaries were found to be distractions. Further, they found that the effect was amplified for students who did not have access to much interactive technology in their

homes. Their consideration of students' access to the technology is an important aspect of the study that was not present in Dalton and Rose's (2014) analysis.

Purpose or Focus

The literature examining the differing purposes or focuses of instructional technology compares the tools' focuses; for example, is the tool's main purpose to teach content or strategies? The research is complicated by widely differing means of analyses, which itself is indicative of the differences highlighted by Leu and others within the New Literacies framework. Examining the occurrence of features, Guernsey and Levine (2014) summarized a study by the Joan Ganz Cooney Center and New America that analyzed the available digital media and interactive technologies in the early literacy landscape. They found that the majority of popular apps for reading focus on building decoding skills (i.e., letter identification and phonics) in comparison to other critical concepts and skills involved in reading. They advise developers to also focus on designing apps for vocabulary development, comprehension, and oral language skills.

Cherner et al. (2014) classified educational apps in four categories: skill-based, content-based, function-based, and "educational misfits," which the authors defined as apps that were erroneously classified as educational since they do not have educational content, do not help develop students' literacy or numeracy skills, or do not allow students to create or present projects. Within those four categories, the authors classified the apps by subjects (English language arts, mathematics, science, and social studies) and by non-subject-specific apps, including teacher resources and instructional apps. Burnett (2010) summarized research on technology and literacy for children up to age eight in educational settings from 2003–2009, and identified three categorizations of technology: technology that supported the development of

print literacy skills, technology tools that are sites for children to interact around texts, and technology tools that serve as media for meaning-making. Burnett's (2010) study was framed within a consideration of the effects of educational background and sociocultural factors on technology, including how "technology and children may be 'acting upon' literacy in educational settings through recontextualizing meanings from other domains" (p. 247).

Individual Programs

Research regarding the individual programs evaluated the effects or efficacy of individual pieces of technology, either at the level of individual tools or through a wider analysis of the technology's efficacy in the educational setting overall. Overall the research found mixed results, with small benefits of technology in specific settings, e.g. on fluency but not comprehension, or in a specific subject or demographic section.

In a review of the extant literature, Luo et al. (2017) found limited evidence for the efficacy of adaptive learning technologies in supporting struggling young readers' comprehension. They decided to investigate the use of the Istation reading program, a product growing in popularity across U.S. schools, to determine its effects on third-grade reading scores. They found a strong correlation between the usage of Istation and the rise of most students' reading achievement scores, with a greater impact on low-achieving (Tier 3) students' scores. They hypothesized that the teachers' other differentiations and individualized scaffoldings, as well as students' home use of the technology, may have had a positive influence on the students' academic performances outside of the influence of the technology.

Brann et al. (2014) examined research on two reading instruction programs for the elementary levels: RAVE-O Program, a multimedia program that was designed for young readers with language or learning disabilities, and Project LISTEN's Reading Tutor. They found

that the use of RAVE-O had a positive impact on students' reading skills and reading attitudes, and the use of Project LISTEN resulted in significant student progress in their reading skills and reading attitudes. In a similar study, Zamora and Pittman (2018) examined the effects of two reading software programs with second graders, ABCMouse and Starfall, on students' reading performances, and found that 85% of students improved between the pre- and post-tests benchmark skills. Neither study indicated the demographics of the student population used in the research, an important aspect because students' socioeconomic statuses or English language learning statuses can have strong impacts on the roles and effects of technology on student learning, as noted by critical technology theorists and discussed above. Lange (2019) examined the efficacy of Fluency Tutor as a tool for improving reading fluency for low socio-economic elementary school students; their conclusion, like others, was cautiously positive but noted the need for teacher involvement and feedback, and they warned of challenges due to poor implementation. The researchers noted that "effectiveness was severely limited and perhaps even detrimental for students who could not get onto the program regularly at their defined times" (p. 1347), one of the key issues noted in critical technology theory.

A study of MindPlay Virtual Reading Coach (MVRC) by Kloos et al. (2019) found that the product had a positive impact on students' reading fluency, with limited impact on phonics or listening vocabulary. However, the study notes the concerning finding that the teachers were overwhelmingly negative about the product and did not want to implement it in their classroom. Their concerns were based on students' frustrations with the product and teachers' feelings of being unable to "connect effectively with students during their MVRC learning experience" (p. 10).

Moser et al. (2017) examined a 10-week word structure intervention that taught common word patterns, with their parts (consonants, vowels, digraphs, etc.) and principles (segmenting, sequencing, etc.), to a group of fourth graders using mobile apps. The intervention had no impact on oral fluency but did show statistically significant improvement in standardized vocabulary and comprehension measures. However, while the authors noted that they expected to see an increase in positive attitudes towards reading and self-concepts as readers, they ultimately found that there was no change.

There are several studies and papers that examine the general efficacy of aspects of Reading Plus, the program used in this research study. A 2013 report by the Miami-Dade public schools examined the reading scores on Stanford Achievement Test, the Florida Comprehensive Assessment Test, and the Florida Comprehensive Assessment Test of all students in grades 3 through 10 who used Reading Plus during the 2011-2012 school year. The study found that Reading Plus had "a consistent beneficial impact on the achievement of the students who used it" (Urdegar, 2013, p. 7).

A study published in *The Elementary School Journal* in March 2019 examined the results of a randomized controlled trial on the impact of the use of Reading Plus with 426 fourth- and fifth-grade students in an urban US school district. The data showed that students using Reading Plus achieved 36% larger reading achievement score gains than students in the control group, with the largest reading rate gains by fourth-graders and less efficient readers, and the largest reading achievement score gains by fifth-graders and more efficient readers (Spichtig et al., 2019).

Reading Plus conducted a research study during the 2013-2014 school year to measure the effect of Reading Plus practice on reading proficiency, using 204 students from two middle

schools with predominantly African American students who qualified for free/reduced-priced lunch. Using a standardized third-party measure of reading proficiency, the Group Reading Assessment Diagnostic Evaluation (GRADE), the study found increases in Total Test Normal Curve Equivalent (NCE) scores associated with Reading Plus practice, with a higher increase correlated to completion of more lessons. Furthermore, the GRADE Standard Score gains achieved by the students who completed 100 or more lessons exceeded the gains (5.8 points to 4.9 points) measured in the Enhanced Reading Opportunities (ERO) studies published by the U.S. Department of Education; additionally, the gains achieved by Reading Plus students were attained in less than one-third the amount of instructional time (30 hours vs. 98 hours) (Reading Plus, 2015).

In a review of research on the effects of technology use on reading achievement in K-12 classrooms that looked at 85 qualified studies based on over 60,000 K-12 participants, Cheung and Slavin (2011) found that the technology solutions overall produced a positive, though small effect in comparison to non-digital methods, but this result varied by the type of technology. They found that supplementary digital programs such as Headsprout did not generally produce educationally meaningful effects, but comprehensive models that combine the use of reading technology, such as READ 180, Writing to Read, and Voyager Passport, with the support of extensive teacher professional development in those programs, showed larger effects. They noted that additional, randomized studies are necessary to confirm the degree of impact. An important note in their study was that the largest impact was found at the secondary level and within lower-ability and English language learners.

Gifted Students and Instructional Technology for Reading

After observing the experiences of Annabelle and other gifted students as they used instructional technology tools for reading, I became curious about the tools' efficacy with that specific student population and those students' experiences with the programs. There is some published research into better understanding gifted readers and their use of instructional technologies. The majority of sources investigated questions such as: How do gifted students' reading habits differ from other students' habits? (e.g., Sousa, 2009); How should pedagogy and content be optimally adjusted for gifted students? (e.g., Tomlinson, 2014; VanTassel-Baska & Stambaugh, 2012); and How can technologies best serve to motivate and engage these students? (e.g., Housand & Housand, 2012). There is, however, little research around the effectiveness of reading instructional technology tools in meeting the unique needs of gifted students. Sally Reis, a gifted education expert at the University of Connecticut who has conducted extensive research on reading and gifted students, observed that her own one-on-one work with gifted students regarding their preferences and experiences with reading technology has given her some insights, but to her knowledge there is no research vein that addresses questions surrounding student expectations and reflections on their use of reading technologies in or out of school (personal communication, July 18, 2019).

In this section I will first review the literature on gifted students' reading habits, including best practices for reading instruction. I will then look at the role of motivation and engagement in gifted students' experiences and preferences, because this has an important role in both their experiences with technology and their experiences with Reading Plus. Finally, I will examine the literature on how gifted students use technology.

Adaptations and Variances in Gifted Students' Reading

Researchers in the field of giftedness and reading instruction have found a number of characteristics of gifted and talented students' reading habits and provide suggestions for best practices in curriculum and pedagogy for those students. Reis (n.d.) noted that many gifted students start reading at an early age, read at least two grades above level, and are often self-taught. Sousa (2009) found that areas of advanced competencies for gifted readers include awareness and special interest in English and other languages; expressive and advanced communication skills; and advanced reasoning, negotiation, and debating skills. Lu et al. (2017) examined the characteristics, reading and learning methods, and use of strategies for understanding and memorizing by gifted and talented students and found that reading time, reading material types, and level of interests are higher than or different from non-gifted and talented students. They also found that gifted students generally have a more favorable perception of teachers' instructions, and more positive relationships with teachers than non-gifted students.

Since 50 to 70% of traditional reading material at any given grade level in school can be irrelevant to meeting the special needs of gifted and talented students (Reis, n.d.), adaptations to the curricula and pedagogy for gifted and talented students include compacting or accelerating the curriculum so students can move through it more quickly, giving these students freedom, choice, and some guidance to select their readings. They especially require being taught advanced reading strategies and posed higher-order thinking types of questions rather than rote vocabulary or low-level comprehension questions. Such authors as Tomlinson (2014), Maker and Nielson (1995), VanTassel-Baska and Little (2016), and VanTassel-Baska and Stambaugh (2012) provide frameworks and recommendations for differentiated curricula for above-level

readers. VanTassel-Baska and Little (2016) recommend having students paraphrase important quotations; summarize main ideas and provide text-based evidence to support their arguments; and generate new ideas from ideas of the text under study.

Motivation and Engagement in Gifted Education

A key facet of developing curriculum and pedagogy for gifted and talented students is addressing issues of motivation and engagement. In a dated but important historical meta-analysis of research on achievement motivation in gifted students, Dai et al. (1998) noted that these students' motivation to learn has been widely studied. Over time, research in the field has moved from an examination of energy level and enthusiasm to investigating students' zeal and vigor. Dai et al. applied a social-cognitive model to look more closely at the salient social-contextual factors, personal factors, and self-processes that affected these students' achievement-related behaviors. In a later review of the literature, Clinkenbeard (2012) identified five key, prevailing theories about gifted and talented students' motivation for learning: expectancy-value framework, intrinsic-extrinsic motivation theories, goal orientations, self-efficacy and other self-perceptions, and attribution theory. Based on studies into mastery goal orientation, performance goal orientation, and the level of challenge within a curriculum, Little (2012) determined that gifted students' motivation and engagement with a curriculum are dependent upon an alignment of the student's goals and values with the curriculum, being presented with the appropriate level of learning challenge, and curriculum's personal meaningfulness or relevance in the curriculum as it is balanced with students' boredom and interest.

The American Psychological Association's Center for Psychology in Schools and Education created a list of the top 20 most important principles from psychology in the context of PreK–12 classroom teaching and learning with gifted children and youth (American

Psychological Association, Center for Psychology in Schools and Education, 2017). The project was modelled after APA's 1997 effort to identify Learner-Centered Psychological Principles. Five of their findings are particularly relevant to this study. First, they found that gifted students' beliefs or perceptions about intelligence and ability affect their cognitive functioning and learning. Gifted students' beliefs about their abilities connect to the research question in this present study about the students' academic confidence as well as intrinsic and extrinsic motivational factors. Second, the research found that students' existing knowledge bases have a strong impact on how they learn, and "overlearning"—repeated instruction of material that is already known—does not increase high-ability students' knowledge or learning. Finding the students' zones of proximal development and offering accelerated or compacted curriculum is preferable for these students. Third, intrinsic motivations rather than extrinsic motivations are more effective in fostering students' academic achievements and enjoyment of learning. Questions around gifted students' motivations, including issues around intrinsic versus extrinsic motivation and the importance of "grit" have been widely studied (Gottfried & Gottfried, 1996; Clinkenbeard, 2012; Duckworth et al., 2007). Fourth, adoption of master goals—rather than performance goals—are more effective motivators for students to persist in the face of challenging tasks and process information more deeply. Fifth, setting goals that are "short-term, specific, and moderately challenging" are more motivational than goals that are "long-term, general, and overly challenging" (American Psychological Association, Center for Psychology in Schools and Education, 2017, p. 25). These specific findings tie into the questions and findings of this research study and to the general discussion of gifted students and technology.

Technology Tools and Gifted Education

Housand and Housand (2012) cite several factors related to gifted students' motivation around technology tools, arguing that technology itself is a source of motivation for gifted students, particularly when it is used in real-life settings and in skills that are related to control and autonomy, challenge, collaboration and cooperation, curiosity, and recognition. Zimlich (2016) concurs, arguing that gifted students' abilities to control the choice, depth, and breadth of content, and pace of learning, as well having authentic and meaningful learning experiences are vital for engaging students' interests and motivations, which are crucial to their success. The research in this field clearly illustrates the importance of considering gifted students' engagement and motivation when selecting and using any instructional tools, but particularly instructional technology tools.

The conclusions of Chen et al. (2013) in building a working framework for the inclusion of technology in gifted education largely parallels the results that Yang et al. (2018) found in their meta-analysis on technology in education, cited above. Yang et al. (2018) found that the primary functions of technology in reading instruction were to enhance student engagement and motivation, engage students in multimodal learning, and promote collaboration. Chen et al.'s (2013) three-pronged framework calls on the use of technology to enable the expansion of the capacity and efficiency of gifted education; to enhance the quality of gifted education by strengthening such features as content presentations, pedagogical features, problem-solving and critical thinking skills, and community activities; and to transform gifted education by expanding access to gifted programs and creating new opportunities for collaboration, personalization, and creativity.

Best Practices for Optimal Integration of Technology into Reading Instruction

The literature includes a variety of studies and articles with conclusions for best practices in using instructional technology for reading. These can be broadly grouped into three categories relevant to my study: student choice; pedagogical practices; and design of the technology tools. No definitive recommendations for best practices come through in the literature, though, a fact perhaps explained by Dalton and Rose's (2014) argument that the field of reading is still in its early stages in understanding how to effectively teach students to understand the full range of print and digital texts.

Choice in Content

The literature is overwhelmingly in agreement regarding the importance of giving students choices of content and offering appropriate, relevant content selections within instructional technology tools. Brann et al. (2014) cite several studies demonstrating the positive impact of providing students choices for their content, activities, and programs, including The Reading Tutor in Project LISTEN, which allows students to choose among a selection of texts. Ciampa (2012) cites student motivation towards reading as a crucial factor in engaging children in learning to read and a prime indicator of later reading skills, arguing that motivated readers "read more, have larger vocabularies, use more complex cognitive strategies, and thus become better readers" (p. 2). Ciampa argues that new literacies and the use of digital texts are a motivating factors in encouraging young students to read.

The framework of critical technology highlights the need to recognize the different impacts of technology on students. To address that, teachers' use of culturally responsive literacy practices with content that is appropriate, relevant, and suitable for a wide range of students is vital to ensure successful reading achievement. Examples include culturally relevant content and

content that is appropriate for dual language learners, incorporating content in multiple languages, and building in translation features and technology tools with verbal and visual clues (Nemeth, 2015). Bennett et al. (2017) note that culturally responsive educators must "know themselves, understand their own culture, and have a conscious self-awareness before they can teach others;" holding high expectations for their students; offering scaffolded instruction; and approaching their instruction from a viewpoint of flexibility and fluidity (p. 242).

Pedagogical Practices

Research regarding pedagogical practices using instructional technology vary in focus from details of instructional strategies to topics of differentiation and equity of access, though all agree on the importance of considering and attending to students' individual needs and experiences. Coiro (2012) cites several pedagogical practices that researchers have investigated for improving reading, including problem-based inquiry, explicit strategy instruction, collaboration and discussion, and peer-to-peer scaffolding (p. 414). Wang et al. (2009) argue that instructional technology should be used in inquiry-based learning to "(a) enrich and provide structure for problem contexts, (b) facilitate resource utilization, and (c) support cognitive and metacognitive processes" (p. 381). The International Reading Association (now the International Literacy Association; New literacies and 21st-century technologies: A position statement of the International Reading Association, 2009) recommends two core practices for all reading teachers to follow: using technology skillfully by embedding "critical and culturally sensitive thinking" and ensuring equal access to all technology (p. 1).

Wang et al. (2009) also note the importance of differentiating the content and exercises to adjust for differences among students' cognitive and physical development, including such factors as hand-eye coordination and motor skills, attention span, self-awareness, and autonomy,

and complexity of the problems presented within the technology. Taking these differences into account, instructional tools should offer scaffolding and guidance as needed. Differentiation in content and pedagogy, as well as personalized consideration in scaffolding, is vital in addressing the differences among students' abilities, aptitudes, and backgrounds.

Universal Design for Learning

The goal of universal design for learning (UDL) within the setting of instructional technology is to maximize accessibility and usability of technology products for all students. Biancarosa and Griffiths (2012) call for school systems and policy makers to require that their funding be spent on instructional technology for reading that follows best practices of universal design, which is required for teachers to be able to support the most diverse range of students. They argue that text-to-speech capabilities are most common and often the only UDL features of many technology tools, which by themselves are insufficient to support all learners. The Designing for Children Guide, created in 2018 by experts in a variety of disciplines, including designers, psychologists, neuroscientists, health care specialists, educators, and children's rights experts, is a continually updated list of 10 principles for designing products and services for children, including apps, content, services, and physical products. The principles include universal usability, privacy and protection, leaving room for voice and agency, being clear in communication, and encouraging options for interactive play and passive time (Designing for Children's Rights, n.d.).

Dalton & Proctor (2007) describe their work in developing universal literacy environments (ULEs) that provide students with a variety of features that support individual learning needs within the interactive nature of their reading. Their work focuses on comprehension building by developing "engaged, active, and strategic readers who are able to

make sense of complex language in a variety of educational content domains" (p. 425) within a population of students that includes struggling readers, dual-language learners, and students with hearing disabilities or significant cognitive disabilities. They call for the use of multiple means of representation, including the use of a text-to-speech tool, hyperlinks, and support for translations; multiple means of strategic learning and expression; and multiple means of engagement, including scaffolded supports, choice and control for the students, self-assessment, and the use of culturally and personally relevant literature examples. Dalton and Proctor (2008) note that UDL often focuses on students outside of the general-education community—struggling readers, readers who need special assistance, and dual language learners—but they argue that UDL is an inclusive framework that should be applied for scaffolding, support, and many other purposes throughout the educational setting.

Hirsh-Pasek et al. (2015) evaluated educational apps with the dual purpose of defining best practices in evidence-based app development and from there, setting standards for evaluating and recommending educational apps for children. Using theories from what the authors term the *Science of Learning*, a newly amalgamated research area that broadly examines "how children learn best" (p. 3), the authors articulate four standards that are at the core of learning sciences and that they apply to the development of educational apps: they should be cognitively active, deeply engaging, meaningful, and socially interactive within the context of a learning goal (p. 26).

With a similar intent but within a broader context of contributors, in 2018 a group of designers, psychologists, neuroscientists, health care specialists, educators, and children's rights experts created a guide for designing for children—a top 10 list of key principles that "direct the development towards products and services that have ethics and children's best interests at their

core" (Designing for Children's Rights, n.d.). They include the need for universal inclusion and accessibility, regardless of the users' genders, ages, abilities, languages, ethnicities and socio-economic statuses; support of children's curiosity and exploration within a safe and scaffolded educational environment; the opportunities to collaborate and share; and protection of the children's data and identities.

Ideals of UDL are closely linked with critical technology and New Literacy theories because they, too, recognize the differences in the impact and interactions that students have with technology regarding issues of accessibility and usability. For example, such theories are directly relevant to the issue of accessibility for students who are dual-language learners and struggle with understanding the computer-generated voice and pronunciation.

The research and theoretical recommendations in the areas of technology, reading, and gifted education for elementary grades offer relevant findings and significant questions regarding the intersection of the three fields as they relate to my study. These findings highlight existing understandings about the nature of technology use, the experiences of gifted students in the classroom, and the successes and shortcomings of instructional technology tools for reading. The literature also brings to light areas in which research has not made clear experiences, preferences, and best practices, such as: How well do the tools adapt to the unique capabilities and interests of the students? How do gifted students experience technology tools for reading? Questions such as these, explored in this research study, will highlight best practices for creating, selecting, and using technology tools for reading with gifted students.

Chapter 3: Methodology

Overview

The research around the key components of instructional technology for reading and the experience of gifted students within that educational area provide vital background information and answers to key questions about current products, understandings, and best practices. The questions of how students learn to read, what obstacle and challenges they face in doing so, and how educators can facilitate reading achievement have all been thoroughly examined, though experts in the field have come to neither a consensus nor a full understanding of the processes, challenges, and best practices. The field of instructional technology has even more disagreement and less clarity, with the main consensus around the fact that technology is rapidly changing, has myriad impacts on the education process, and requires further extensive research and professional development. When the third focus of my research, gifted education, is brought into the discussions of best practices in reading instruction and instructional technology, the areas of certainty and consensus are very few. This has led me to refine and focus my research questions to look at the point at which all three components merge, asking: *How do personalized learning programs' instructional designs match gifted students' experiences in using them?* To further refine my research, I looked at these sub-questions:

- What assumptions about how the reading process works at different developmental stages do software developers make in building personalized learning programs in terms of the reading process, student abilities, motivation, and preferred types of engagement?

- What do gifted students think about their experiences with personalized learning software, in terms of whether and how it aligns with how they prefer to learn and engage with instructional technology?
- How do the developers' assumptions and understandings match the students' self-reported reflections on their experiences using personalized learning software?

To address these questions, in my research project I examined the understandings, assumptions, and expectations that the developers of a personalized reading instruction program, Reading Plus, use in designing their software; I then compared those with the experiences of the fourth-grade gifted students who use it. To reach this goal, I interviewed developers and researchers at the company that produces Reading Plus and then conducted interviews, observations, and surveys with students who use the program.

In this chapter I will describe my research sample and data sources; detail the information needed to conduct the study, explain the research design and data collection methods, report on my data analysis and synthesis process, review ethical considerations and issues of trustworthiness, and summarize the limitations and delimitations of the study.

Research Sample and Sources of Data

To address my research questions and sub-questions, I looked for two sets of research participants. First, I needed an instructional technology company that focused on reading that I could use as the source of research and theory around reading and instructional technology and that I could have the student research participants use. Reading Plus (www.readingplus.com) is an adaptive, personalized literacy instruction product that is marketed for grades 3-12. The company was of high interest to me as a possible research participant because it is an 80-year-old, family-owned company that invests heavily in research around reading, including a large-

scale refocusing in the early 2000s that brought on experts in the field of reading to help the company build the optimal tool for reading instruction. I contacted P. David Pearson, an expert on reading who has served as a consultant to Reading Plus, and I asked for his suggestions for an instructional technology product to study in my research . He recommended Reading Plus as a research subject because of the company's dedication to research and high-quality implementation. Furthermore, it is used at the gifted PreK-8 school that I used for my research site, as described below. Reading Plus was the recipient of a National Institutes of Health grant in 2018 for an analysis of their product that looked at student engagement and motivation, and a key part of their promise is to tap into students' individual interests, engaging and motivating them to work at their peak levels of performance. Alexandra Spichtig, the director of research at Reading Plus, said the company has focused on what motivates students, looking at "how the student fits into the learning journey for themselves"—in other words, how the students decide on and shape their learning experiences—as well as how that journey changes over time and how the student chooses the journey. The emphasis by Reading Plus on students' experiences, motivation, and engagement makes the software well-suited to use in answering my research questions, which center on the match between the software's intentions and the users' (i.e., students') actual experiences and perceptions of it. The one potential drawback of using Reading Plus as my focus was that the company is not specifically geared for above-level students; rather, it is more commonly used to address the challenges of struggling or below-level students. Because the aptitudes, abilities, and interests of gifted students differ from at- and below-level students, I did not want to use the students' performances on Reading Plus as an indication of shortcomings on the part of Reading Plus. Rather, I sought to examine how gifted students as a specialized group would experience a high-quality personalized learning company.

After selecting the personalized learning tool that I would examine, I needed a set of student participants to use and discuss it. I chose a sample of convenience, which was my daughter's school: a private, PreK-8 gifted school in the Chicago area that uses Reading Plus in its upper elementary grades (2-5). The school has approximately 265 students and a selective admissions process that requires a minimum IQ score of 125, teacher recommendations, and evaluative shadow days by the students. These selection criteria are consistent with the National Association for Gifted Children's recommendations for identifying gifted children, which comprises a systematic, multi-phased process that includes a nomination phase; a screening phase that includes multiple identification tools that are both objective, such as individual intelligence achievement tests, and subjective, such as teacher observations, nominations, and portfolio and performance assessments; and a placement phase (NAGC, n.d.).

I further refined the research sample by focusing on the fourth-graders at the school, thus narrowing the sample to a range that would typically be Chall's Stage 2 readers. Though I had originally planned to talk with third- and fourth-graders, I narrowed my sample to just fourth grade in an effort to limit the range of academic abilities within the group and thereby make a more homogenous sample. Each grade at the school has between 32 and 45 students. I decided to select eight students from the fourth grade to participate and to meet with each of them four times for 30-45 minutes, using a combination of surveys, interviews, and observations to gather my data from them. Having a smaller group of students and meeting with them more frequently and for longer periods, rather than doing less detailed research on a broader sample of students, was preferable for my grounded theory methodology because it allowed me to develop my theories through multiple, in-depth conversations and observations with the students.

I emailed the parents of all 32 fourth graders with a description of my research project and a request for them to consent for their children to participate. Of the 32 families, nine gave their consent for their children to participate, one family declined, and the other families did not respond. I selected the first eight children whose parents consented; the group comprised five girls and three boys. Because I knew that the school's population was relatively homogenous in terms of their geographical areas, educational backgrounds, and socioeconomic statuses, I did not request any demographic information from the families beyond the number of years that the students had attended the school. I felt that the additional demographic information would not contribute much meaningful data to my study and that requesting it would cause parents to be less willing to participate.

Information Needed to Conduct the Study

The process of obtaining answers to my research question required a variety of types of information and data, both from Reading Plus and from the students. The data fell into three categories. First, I needed informational data regarding the features and functionality of Reading Plus. This included information about the product's administration as well as the features and functionality of the product, answering such questions as the following: How would I set up and administer accounts for the students? How does the product evaluate the students and offer them content? What specific features of the product are designed to engage and motivate the students? Second, I needed perceptual data from the students regarding their experiences, preferences, and understandings about technology and reading in general and personalized learning tools and Reading Plus in particular. This qualitative data could be obtained only through surveys, observations, and conversations that elicited the students' thoughts and feelings. Prior to this work, I completed a qualitative study in one of my doctoral classes in which I interviewed first-

and second-grade teachers at the school about their use of technology, including their use of Reading Plus, and I observed their students using the software. I used the lessons I took away from that experience to shape the format and questions of the interviews and observations I did in this research. Finally, I needed to obtain theoretical information from the literature sources on the topics of my study—technology, reading, personalized learning, and gifted education—and from the research and theoretical framework that Reading Plus uses to formulate the plans for their product.

Rationale for Qualitative Research Design

I chose to approach this study using a constructivist paradigm with a grounded theory methodology that helped me examine the developer's assumptions and understandings as well as the children's views and experiences through their own words and lived experiences (Seidman, 2013). Chilusa and Kawulich (2012) explain how the constructivist paradigm sees knowledge as subjective, socially constructed, and "mind dependent" (p. 9). Within that paradigm, truth is context-dependent and lies within the human experience and there are multiple, socially constructed realties (p. 6). This paradigm fits well with the idea of differing experiences with technology in general and texts specifically as described by my theoretical frameworks of critical technology theory and New Literacy theory. I used a grounded theory approach because relatively little is known or published that investigates my questions, so I was able to build a theory based on the circumstances and conditions of the creation and use of instructional technology for reading (Bloomberg & Volpe, 2016). I chose to use a qualitative analysis rather than a quantitative analysis or a mixed-methods format because I felt that the qualitative method would allow me to see nuances and complexity of themes such as confidence, motivation, control, and personal preferences and experiences around technology; a quantitative analysis

would miss many of the subtleties that came through in the students' verbal responses and physical activities during the observations.

Overview of Research Design

I conducted a review of the literature to inform my study, looking at the themes of personalized learning and instructional technology tools, reading instruction, and gifted education. My goal was to understand the individual themes that informed my research questions so that I could bring a fuller understanding of the existing research and assumptions to a relatively uncharted topic: the intersection of personalized learning tools, reading instruction, and gifted students.

After the completion and defense of my introduction and literature review, I completed and defended my research proposal, which laid out my research plan, components, and timeline. I then submitted my research proposal to the DePaul University Institutional Review Board (IRB). After IRB approval, I began the consent process, contacting the staff at Reading Plus and the parents of the fourth-graders whom I hoped to have participate in the research. Once I obtained the needed consents and agreements to participate, I moved on to starting my research process.

In the first phase, I sought a description of the software and the developers' understandings and expectations around how students will use Reading Plus, and how those understandings and assumptions shape the design and usability of the software. I secured these foundational design aspects by conducting video-conference interviews with the director of research and the product developer at the company and by examining the research studies and materials they cited as germane to building their program's design elements. These interviews were mainly informational, with the Reading Plus staff describing administrative set-up steps for

establishing my administrator account, the students' accounts, and tracking the students' performances, and identifying salient theories upon which the program's functions are based. These were not interviews that probed for preferences of the Reading Plus staff, since the personal opinions and understandings of those contacted were not driving the development of the program.

In the second phase of the study, I surveyed, interviewed, and observed fourth-grade gifted students who use the Reading Plus software in their language arts classes, to learn about their experiences with the software and to compare their experiences with the expectations and assumptions of the developers. Because I was interested in finding out the personal preferences, experiences, and understandings of the students, I used multiple qualitative methods and triangulation to help me examine the trends and themes of the students' experiences from a variety of angles. In my final course in my doctoral program, I conducted a pilot version of the interviews in which I interviewed three fourth-graders about their experiences and preferences of using technology in schools. That project helped refine my line of questioning for this study.

There were eight steps in my study process, as shown in Figure 1. First, I conducted informational meetings with the director of research and product development manager for Reading Plus in which they shared an overview of the product, including administrative details and the theoretical research influencing the software design. After the meetings with Reading Plus, I set up new accounts in Reading Plus for each of the study students. These were entirely separate from the accounts that they used in their regular language arts classes. Their teachers did not have access to any of my data, nor did I have access to their performance in their language arts class accounts. I then held four meetings with the students. In my initial meeting with them, I

administered a survey soliciting their feelings about and preferences for reading and technology tools and, in that same session, I interviewed them with more detailed questions on those topics.

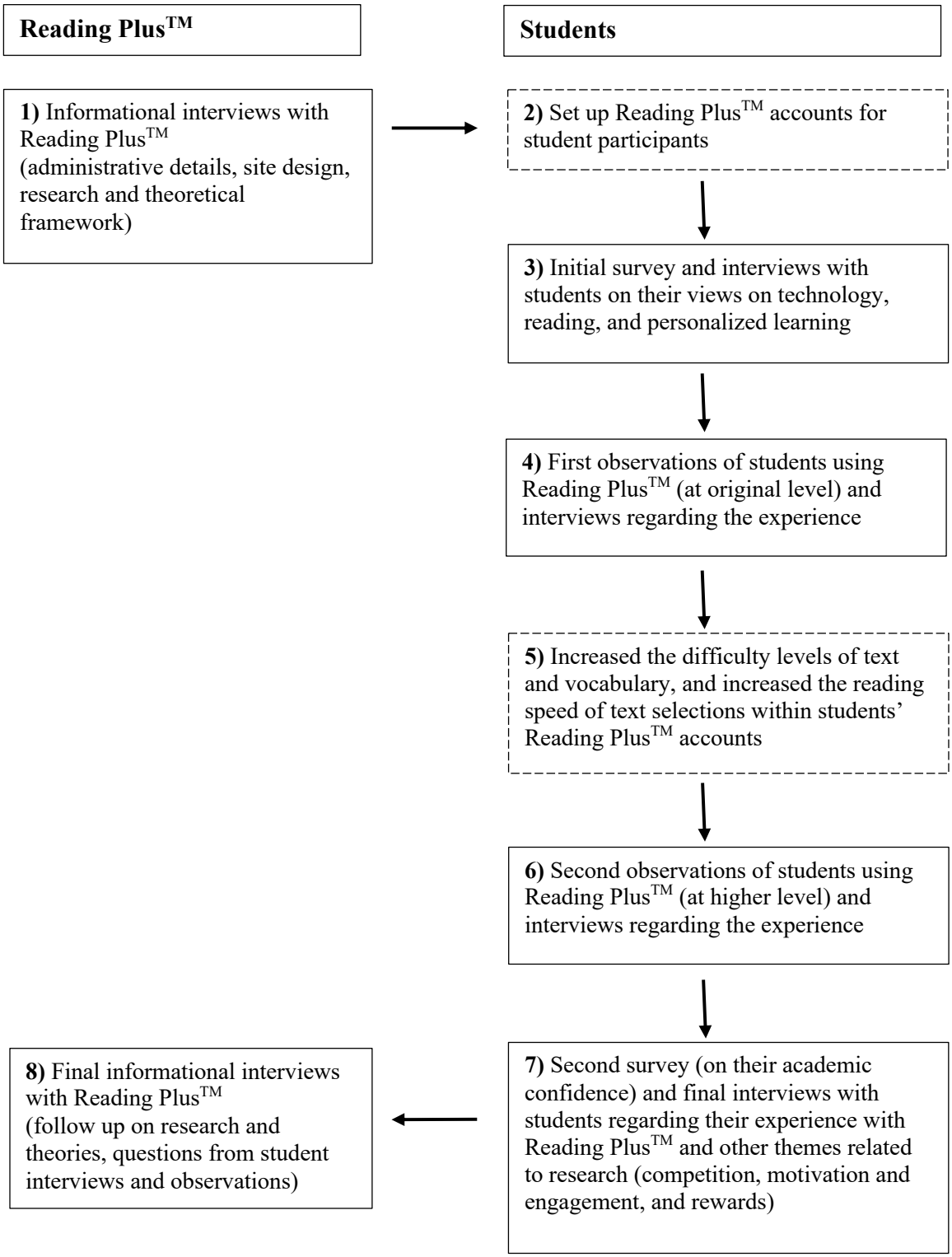
In the second meeting with the students, I asked them to use Reading Plus to read a text selection, complete the post-text assessment, and engage in the Reading Plus vocabulary exercises that are designed to gauge their overall grade-level vocabulary knowledge. I used the observation protocol to take notes on such aspects as their posture, attentiveness, absorption, frustration, confidence, and speed of work. I then interviewed them about their experiences with and feelings about Reading Plus as well as their preferences for working on digital versus print platforms. After that meeting, I increased the difficulty level of the text and vocabulary, and I increased the reading speed of the text presentation on Reading Plus for each student participant.

In the third meeting with the students, I notified them of the changes I had made to their accounts on Reading Plus and asked them to read a text selection, complete the post-reading assessment, and do one of the vocabulary exercises on Reading Plus that tests their vocabulary knowledge specific to their assigned aptitude level (not specifically tied to the story they had most recently read). I used the observation protocol to note their behavior and body language and to compare it to their previous session when they were at an easier level in Reading Plus. I then interviewed them about that experience and posed additional questions about their feelings and experiences around tests, effort, choice, and control in their schoolwork. In the fourth meeting I asked them questions about competition, motivation and rewards, creativity, group work, and scaffolding—topics gleaned from the research on how gifted students differ from their non-gifted peers (Little, 2012). I did not ask them to use Reading Plus again, as I wanted to use that time with them to discuss more general topics related to the literature on gifted students as well as their perceptions of the software design features that affected their processing and enjoyment.

After I completed the fourth round of interviews with the students, I spoke with the director of research at Reading Plus to follow up on questions that I had resulting from our earlier conversations, my research on Reading Plus, and details that emerged in my interviews with and observations of the students. I wanted to fill in holes in my information and understanding to help answer my third research question, discussing specific areas of overlap or disconnection between the students' experiences and preferences and the understandings and features of Reading Plus. My questions focused on product information, such as confirming the number of stories in their collection or how the product balances building sight-word recognition and decoding skills, and questions related to my first set of four findings around academic confidence, challenge, motivation, and creativity and control, such as how the product works for students who have achieved or surpassed grade-level proficiency.

Figure 1

Flowchart of research design



Once I completed the observations and interviews with the students, I transcribed them, coded them into thematic units using NVivo, and analyzed them using qualitative research techniques. I then compared the framework and research of Reading Plus and the resulting implementation of features and functionality with the preferences, viewpoints, and experiences of the students who used it.

Data Collection Methods

Reading Plus: Informational Interviews

The first step in my data collection comprised two informational conversations with the director of research and product developer at Research Plus conducted by videoconference and a series of follow-up emails with more specific questions and requests. These informational meetings needed to be the first step in my research so that I could understand how the software worked, both from an administrative perspective and from the students' perspectives. I also needed to understand the research and theoretical framework behind the program—why was it built in the way it was? Why was each feature included, and how did it work? What are the assumptions and understandings on the part of Reading Plus developers about how students learn to read, use an instructional technology tool for learning how to read, and demonstrate full understanding and mastery of the story content as well as reading skills and vocabulary knowledge? How are the theoretical constructs of Reading Plus related to reading instruction in general and developing instructional design elements for reading specifically put into practice in the product? I could work with the information from the interviews as well as the published research findings and marketing materials to build a complete story of the development, theories, and functionality of the product.

Student Surveys

I asked the students to complete two surveys, one in the first meeting and one in the final meeting with them. The first was a 13-question survey that I created that asked the students about their comfort levels and preferences regarding technology and reading. I administered the survey through Qualtrics; the students finished it in about 10 minutes. (See Appendix A for the full text of the survey.) I designed this survey to elicit students' feelings about and preferences for reading and technology in general so that I could separate them from their perceptions of using the Reading Plus software.

The second survey I administered to the students was the Academic Self-Perception subscale derived from the School Attitudes Assessment Survey (SAAS; McCoach & Siegle, 2003). This subscale measures students' senses of their academic abilities, using a seven-point scale. I chose this survey because a key feature of Reading Plus is building students' academic confidence, so I wanted to see how confident the students were already and what effect that level of confidence would have on their experiences with the product. How would they respond to features that were intended to boost their confidence levels, if they were already high? The survey was designed for students in grades 6-12, so it was slightly above the grade level of the students in my study. Given that these students routinely perform at academic levels above their current grades, and given that the items are relevant to issues and school components with which they are already familiar, I anticipated that these students would find the survey items relevant and meaningful. All participants completed the survey without any apparent difficulty. (See Appendix F for the full text of the survey.)

Student Interviews

I conducted four interviews with the students, all of which were held in empty offices or classrooms at the school before, during, or immediately following school hours. The interviews

ranged from 15 to 45 minutes, depending on the lengths of responses from the students. I recorded the interviews using my phone and had the conversations transcribed by a professional transcription service. I listened to the interviews again to review the contents and correct any errors in the transcription.

In my first interviews with the students, my questions focused on their general habits and preferences around technology and reading. My goal was to understand their general attitudes about school, reading, and technology outside of their experiences with Reading Plus. I wanted to identify and separate any strong opinions they had about those topics outside of Reading Plus specifically so that their opinions would not be taken as a reflection of their feelings about Reading Plus. On the topic of technology, I asked if they liked to work with computers, inquired about challenges they faced with technology, and asked if they felt that technology changed the way they learned. On the subject of reading, I asked if they liked to read, the types of books they read and how they found them, and I asked what formats they preferred to read in. (See Appendix B for the full text of the first interview.)

The questions in the second interview focused on their experiences in using Reading Plus. I asked general questions about their feelings about Reading Plus as well as questions about the last thing they read on the product, how and why they chose the text selections, and how difficult they found them to be. I also asked about their feelings and experiences around test-taking, including whether they preferred to take tests on the computer or paper and whether one format or another made them more nervous. Finally, I asked if they generally read a piece of text line by line, skipping, or skimming. The purpose of these interview questions was to learn about their feelings towards Reading Plus in general and toward some of the features of the product in particular, including the guided reading window, the students' ability to choose their text

selections, and their experiences with the vocabulary and content assessments. (See Appendix C for the full text of the second interview.)

In the third interview, I focused on evaluations, choice, and control, which are all topics of research by both Reading Plus and within the gifted education literature. I asked the students if they felt that the tests and assignments at the school accurately evaluated what they knew, if they were fair, and if they were more based on effort, achievements, or attainment of academic goals. I asked the students about their favorite and least favorite classes and their best and weakest subjects, as well as questions about their sense of control over the assignments and their motivation, including their feelings about rewards. (See Appendix D for the full text of the third interview.)

In the fourth interview, I focused on three key themes that the students spoke about in earlier interviews as well as questions related to the assumptions and research of Reading Plus and some key themes in research on gifted learners. The first set of questions focused on the students' motivation, their views about challenges and boredom, and their sense of competition. The second set of questions asked about their views on the role of technology in school. The last set of questions asked them about their feelings around their control within Reading Plus and their preferences for instructional groupings (e.g., if they would prefer to work by themselves, one-on-one with the teacher, in small groups, or in the whole-class setting). (See Appendix E for the full text of the fourth interview.)

Student Observations

I created a protocol to observe the students while I was speaking with them, and, more specifically, as they were using Reading Plus. The goal of the observations was to attempt to gauge their levels of comfort in the situation and with the technology. I increased the difficulty

level of Reading Plus and then observed the students' reactions to the changes I made, with the goal of ascertaining their reactions to increased difficulty and challenges in academic projects. In my observations of the students, I took note of the students' body language, including signs of attention or distraction, engagement, boredom, and frustration. (See Appendix G for the observation protocol.)

Reading Plus Usage

In the second of my four sessions with the students, I asked students to use the reading and vocabulary features of Reading Plus. I observed them as they choose a text selection and read it; they then answered the test questions at the end of the selection. Once that was complete, I asked the students to complete a vocabulary exercise that gauged their vocabulary levels in relation to grade-level norms and expectations. Before my third session with the students, I increased the difficulty levels of the text selections and vocabulary they would encounter. I also increased the speed of the text presentation in Reading Plus. During the third session, I asked them to repeat the process (selecting and reading a story, completing the questions at the end, and completing some of the vocabulary exercises). Table 2 shows the starting points and increased settings for the students' accounts in Reading Plus. The grade-level setting for fourth grade is reading level D and a reading speed of 175 words per minute (WPM). As shown on the left side of the table, four of the students were at or slightly above the target reading speed and the others ranged from eight to 129 WPM above the grade-level target. One student was at grade level for the reading level; the others were one to three levels above. One student was one level above the grade level for vocabulary, and the others ranged from two to five levels above grade level.

Table 2

Reading Plus Settings for Interviews 2 and 3

Settings for interview 1				Settings for interview 2		
Student	Reading Level	Reading Speed	Vocab level	Reading Level	Reading Speed	Vocab level
1	E	175 WPM	H	F	190 WPM	I
2	F	304 WPM	I	G	320 WPM	J
3	E	183 WPM	I	F	195 WPM	J
4	E	175 WPM	J	F	180 WPM	K
5	D	175 WPM	E	E	180 WPM	F
6	G	188 WPM	H	H	210 WPM	I
7	E	178 WPM	G	F	190 WPM	H
8	F	231 WPM	L	G	245 WPM	L

Note: Fourth-grade level target = Level D, 175 WPM

Data Analysis and Synthesis

I used multiple research methods—interviews, surveys, observations, and results of the students' work on Reading Plus—to collect data simultaneously throughout the research stage of the project. I felt it was important to code them as soon as they were completed and to look at the overarching themes that were emerging across the multiple types of data I was collecting, so that I could delve more deeply into them in later interviews in accordance with the grounded theory methodology. The first data I collected was through the conversations with Reading Plus, and I used that information to start creating themes about Reading Plus that I would ask the students about. I used the initial survey and the initial interview to gather broad themes about technology and reading. As soon as each set of interviews were done, I sent them for transcription and typed up my observation notes.

I used the computer program NVivo to code the interview transcripts, creating a folder for each round of interviews that included a copy of the interview questions, copies of the audio

files of the interviews, copies of the transcripts, and copies of my notes about the observations. After the first set of interviews was complete I read through the transcripts and listened to the interviews again; I then came up with a list of high-level themes. These themes included computers and technology; reading; print versus digital (covering reading, content, assessments, exercises, and extracurricular games and other technology use); school (covering their classes and grades); academic preferences (regarding effort and difficulty of their coursework); and a broad category of experiences, which covered their preferences and experiences around choice, competition, control, motivation, rewards, and their sense of academic self-efficacy and confidence. I added a category for Reading Plus—including the students' experiences with it and preferences around it—and for the informational interviews, research, and other information regarding the product and company. I then created nodes for each theme in NVivo, read through the transcripts a second time, and coded the relevant segments to each node. I exported each node's contents and examined them individually to check for accuracy in my coding. In this process I came up with additional nodes and went back through the interview text to code them again with the new nodes. See table 3 for a list of codes and sub-codes.

Table 3

Codes Used in Data Analysis

Top-level codes	**Sub-codes**	
Academic preferences	Choice Control Difficulty level Effort	
Experiences and preferences	Boredom Challenge Choice	Creativity Motivation Nervousness

	Competition	Personal interests
	Confidence	Rewards
	Control	Trustworthiness
Print vs. digital	Nervousness	
	Preferences	
	Reading (experience, preference)	
	Tests	
	Trustworthiness	
Reading	Choice	
	Enjoyment	
	Content preferences	
	Discovery methods	
	Format preferences	
	Importance	
Reading Plus	Choice	Motivation
	Difficulty level	Research
	Hints/scaffolding	Rewards
	Interest in content	Trustworthiness
School	Classes	
	Effort	
	Grades	
	Group work	
	Tests	
Technology and computers	Access	
	Enjoyment	
	Impact on learning	
	Preferences	
	Teacher vs. computer	

Each round of interviews and the corresponding coding process helped me to expand the themes and revise my questions for the next round of interviews. After I prioritized and combined nodes, I pulled out relevant and important quotes from each section and built them into the discussion of each theme.

During the interviews I took brief notes related to the observation protocol, and immediately following the interviews I typed up a complete description of the interview using the observation protocol. I imported these into NVivo in the folder for the related interview, as noted above.

Issues of Trustworthiness

Questions surround the credibility, validity, and trustworthiness of qualitative research, particularly from the positivist paradigm (Shenton, 2004). In an effort to address these concerns as they pertain to my own research, I will use this section to describe my positionality, examine the ethical considerations that are associated with research with children, and use Guba's criteria (Shenton, 2004) to address questions of credibility and transferability by providing details of my research context and setting and demonstrating that I am portraying an accurate and true picture of the phenomenon and questions to the best of my ability.

Positionality

I bring several different perspectives to the research: I come as a parent, teacher, student, and professional in the field of publishing and curriculum creation. I am a big supporter of technology in the classroom and see enormous potential in its use, but I have seen it misused as a way to babysit students who do not fit into the "normal" group. I have also seen it fail in supporting students who struggle and have seen it be a mismatch for students who are above

level, like Annabelle. Finally, I am aware of the inequalities of access to technology across the socioeconomic spectrum.

My positionality has a strong influence on my research, which I think has both a positive and a negative effect. I hold three roles in relation to the school in which I am doing the interviews with the students. First, I am a parent: my daughter attends the school; she is in fifth grade there. As described above, I have seen Annabelle using Reading Plus and have noted ways in which it was not a good fit for her needs. My second role in the school is as a substitute teacher, which offers me the opportunity to see the students using the technology. Once I started my doctorate, the dynamic shifted again, towards a teacher-student relationship, with me as the student as I asked the teachers for opportunities to do research in their classes, and for their advice on topics around early education. Finally, I have an insider's understanding of the software and development process, having spent 25 years in the field of publishing and curriculum creation, including more than a decade at World Book, Inc., where I developed their digital products, including websites, e-book collections, and an app, in three languages and for all levels of learners from PreK through college. Given this experience, I have opinions about where software is currently falling short in supporting above-level students. My knowledge of the product influenced the questions I asked and the focus I gave towards features and content selections.

Ethical Considerations

The use of children in qualitative research raises a number of concerns around the protection of their rights and privacy (O'Reilly & Dogra, 2017). I put in place safeguards to protect the privacy of the children so that no other parents or children would know who participated in the study. I procured the parents' consent for their children to participate in the

study using a confidential consent form through Qualtrics so that no one at the school—students, parents, or staff—would distribute or see any of the consent forms. The audio files, transcripts, and data analysis of the survey results were de-identified and kept in a secure folder on my computer. The students' teachers were notified only in the cases in which it was necessary to facilitate the students' meetings with me.

Credibility

To ensure maximum credibility of my research, I used multiple methods to ascertain the students' viewpoints and preferences. Surveys provided a way in which I could quantify their responses on a scale common to all participants, and for the second survey I used a tool that had been previously developed and validated. Interviews offered the students a way to use their own voice and words to describe their experiences, starting with questions and prompts that were common to all participants, thus providing a shared starting point and a source of comparison for the discussion. The observations were the most subjective method that I used, as they relied entirely on my judgment regarding the participants' feelings based on their body language. Although the protocol was the same for all students, without asking them if and why they were sitting or moving in certain ways I could only guess or infer as to the cause. Were they shifting in their seat because they were hungry, anxious, bored, or distracted? Were they too cold, or not feeling well? Observations of students give a helpful—albeit highly subjective—view of the students and are useful tools to be used in conjunction with more formal methods (O'Reilly & Dogra, 2017).

Transferability

The specialized demographics of the participant group—high-ability and aptitude, high level of educational experience, and relatively affluent—combined with the specific setting of

instructional technology for reading and gifted students make this a highly specialized study with limited transferability. This is common in qualitative research; in fact, Shenton (2004) argues, "Since the findings of a qualitative project are specific to a small number of particular environments and individuals, it is impossible to demonstrate that the findings and conclusions are applicable to other situations and populations" (p. 69). However, my intent in structuring the research questions and data collection as I did was partially to collect data around the experiences of a set of students who are outside the standard norms, with the idea that the experience of a generalized "other" might be shared with other groups. If the students in my study experienced technology differently because of their aptitudes, outlooks, and preferences, might other student groups share similar experiences of difference? Through the use of thorough description and triangulation of data collection, I hope to present results that have relevance to other groups and in other contexts.

Delimitations

The parameters I set for the study allowed me to have an intentionally narrow focus and enabled me to examine themes at greater depth than a broader study with more participants would have. I narrowed the focus of the research in the three areas—reading, technology, and gifted education—for reasons of practicality and personal interest. I have been interested in the themes of differentiation for above-level/gifted students in early elementary grades because most gifted programs begin at grade 3 (NAGC, n.d.) despite the need for differentiated materials at lower grades. I have been fascinated by technology in elementary education from my years working at World Book on their digital products. Finally, I have always had a personal love of reading, particularly in elementary levels, as a parent in a house where books are treasured friends, and as a researcher, where I have presented at several conferences on using picture

books to create differentiated lessons on topics such as social justice, social-emotional learning, and STEM.

The catalyst for narrowing the research questions of my dissertation was the experience Annabelle had with Reading Plus and Kafka, which brought into focus an area of research at the intersection of reading, technology, and gifted education in the elementary years. The research questions then emerged: first, how was the product built—what was the reasoning and theory behind it and how was those translated into a product? Second, how did gifted students experience it? Finally, how did those two match up?

I initially planned on having a broader sample, with multiple instructional technology tools (Reading Plus and one or two others) as well as two grades: third and fourth. But I realized that having that many options made my research too broad and brought in so many variables that it would be challenging to find themes and draw conclusions. P. David Pearson was integral in having me focus on a single instructional technology tool and in selecting Reading Plus. I realized in thinking about the range of abilities in both third and fourth grade that having students at both grades would give me broad results that would be more challenging to narrow into conclusions and recommendations. I selected the fourth grade because it is typically at the bridge between Chall's stages 2 and 3 within the student population, a key point in the process of learning to read. By focusing on a single technology tool and a single grade, I could ensure that I could eliminate variables and more clearly meet my objective of understanding the theories and implementations of a single, high-quality tool and how a specific, relatively homogenous group of students experienced that tool. Finally, I settled on talking to eight students because that would be a large enough sample size that I would likely get a variety of responses, but small enough to allow me to interview each student four times, getting a depth of information.

I narrowed the factors and features of the study after completing the literature review, which helped me understand the key themes and challenges in each of the three focus areas: technology, reading, and gifted education. I knew of the general challenge of a mismatch between content and ability from Annabelle's experience, and I learned of some of the areas of challenges in instructional technology from the research.

My access to Annabelle's school as the research site was fortuitous because it is geographically close to me and I am familiar with the staff. By selecting that site instead of searching for a different site and/or multiple sites, I was able to set up the research efficiently and effectively, avoiding challenges such as administrative red tape or delays due to becoming familiar with the setting, staff, and students.

Limitations

The limitations of the study were related to the small and homogenous sample, my personal familiarity with the student participants, and my potential bias towards the instructional technology tool, Reading Plus. While the homogeneity of the participant pool was helpful in being able to rule out other influences, such as socioeconomic status, educational setting, and academic level, it also limited my ability to see the impact of technology on a diverse group of people. Two key pieces of critical technology theory are the question of equal and fair access to technology (Selwyn, 2011) and the impact of unequal access to and training on technology. These were not factors in my study, but their inclusion would have strengthened it.

The second limitation was my own potential bias due to familiarity with the participants. As noted above, I am familiar with the school because I am the parent of a student and a substitute teacher there; I have also done some qualitative research projects at the school during my doctoral program. I knew all but one of the student participants and several of the parents

before I began the research. In some ways I think that was a benefit to the study because the students felt comfortable with me and therefore seemed to be able to be more honest and direct about their feelings. But their personal feelings towards me presumably also influenced how they interacted with me, whereas having an unfamiliar interviewer would have removed that dynamic.

The third limitation was that I was already familiar with Reading Plus because of my daughter's use of it, and I had a sense of some of the challenges of using it with a gifted population. My dissertation committee reminded me repeatedly during the early stages of my study formulation and data collection that I needed to strive to limit the preconceived ideas and biases I had about potential outcomes of my study, so I worked hard to be self-aware of any biases that might limit my ability to see my data for what they hold. To overcome my initial hesitations about Reading Plus, I contacted a well-known and respected reading researcher, P. David Pearson, who also serves as a consultant for Reading Plus, and asked him a wide range of questions about my research interest and possible instructional technology products for reading, including his views of Reading Plus. The conversations I had with him about the long history of—and commitment—by Reading Plus to research, as well as the role of expert consultants like him, highlighted for me the fact that Reading Plus is a company that is rooted in high-quality research and is committed to providing the most effective product for its users. His views, in conjunction with the depth of research that Reading Plus has done, helped shift my thinking away from putting Reading Plus in a deficit position before I began my research.

Summary

In this chapter I described how my research interest narrowed to a focus on the intersection of reading, instructional technology, and gifted education. My focus on exploring the experiences and feelings of the students resulted in a need for a qualitative analysis that allowed

for the exploration of themes and development of a theory; therefore, I selected a grounded theory methodology. As qualitative research can be met with skepticism regarding the study's validity and trustworthiness, it was important to discuss how and why my research was credible, transferable, and dependable. In this section I explained how and why I selected Reading Plus as the instructional tool, Annabelle's school as the site of my research, and the specific student population of eight fourth-graders as my student sample. The data collection methods I used were surveys, interviews, and observations, which gave me the breadth and depth of data that I needed to understand and analyze the phenomena.

A qualitative research study is an observational experience rather than an empirical study designed to confirm hypotheses and define conclusions from data that can be applied to the broader population. However, my intent has been to use my findings and analysis to help illuminate challenges that educators, administrators, and instructional technology designers might face and highlight best practices and potential improvements to the field.

Chapter 4: Findings

The information I received from Reading Plus regarding the company's research basis and theoretical framework provided an understanding of how the program is built and how the algorithm and product features support the product's core goal to improve students' reading. The surveys, interviews, and observations with the student participants allowed me to build an understanding of their preferences and experiences around reading and technology. In this section I will summarize my findings under each of the three sub-questions of my research questions.

In the first section of this chapter I will summarize my findings related to the first sub-question, *What assumptions about how the reading process works at different developmental stages do software developers make in building personalized learning programs in terms of the reading process, student abilities, motivation, and preferred types of engagement?* This summary will include a description of how Reading Plus works and the research that informs their product features and functionality.

In the second section I will summarize my findings regarding the second sub-question, *What do gifted students think about their experiences with personalized learning software in terms of whether and how it aligns with how they prefer to learn and engage with instructional technology?* In answer to that question, I have eight specific findings: four are related to general topics of motivation and rewards, challenges and boredom, creativity and control, and academic confidence as they apply to gifted students, and four related to technology and reading.

In the third section I will summarize my findings related to the third sub-question, *How do the developers' assumptions and understandings match the students' self-reported reflections on their experiences using personalized learning software?* In that section I will compare the

theoretical framework of Reading Plus and the company's underlying methods for teaching reading to see if there is an alignment with the needs and preferences of the students in the research.

Part I: The Assumptions and Understandings of Reading Plus

I examined the published data found on the website of Reading Plus, in their white papers, and in journal articles written by staff, consultants, and other researchers to understand the goals of the company; the efficacy of the product in achieving the goals; and the methods by which they do so. I will describe my findings regarding Reading Plus in three sections: first, I will provide a general description of the product's history and overview; second, I will describe the research and theory behind the product; and finally, I will describe how that research is implemented in the product's features and functionality.

Product History and Overview

The company originated in the 1930s in Brownwood, Texas, when the Taylor brothers Earl, James, and Carl invented a series of devices to test hearing and audio capacity, including the Metronoscope, Opthalmograph, VisaScope, and Audiometer. In the 1950s, Earl's son Stanford developed the Reading Eye tabletop eye-movement camera and a tachistoscope, a device that displays content on a screen for a brief period of time, typically to test visual abilities or increase reading speed. In the 1960s, Taylor created the Aud-X Sound/Sight device and the Prism Reader, which was an adaptation of the guided reader window that was used by vision specialists for eye training exercises (Reading Plus, n.d.). In the 1980s, the company developed the Visagraph I system that recorded eye movements to evaluate reading efficiency and visual proficiency. In the 1990s, the Reading Plus product was launched with a focus on "silent reading fluency development, vocabulary improvement through contextual analysis, decoding practice,

extensive reading, and comprehension enhancement" (Reading Plus, n.d.). In the early 2000s, Stanford's son Mark brought on subject experts in reading to help redevelop the product, culminating in the launch in 2013 of a new version of Reading Plus that focused on students' reading capacity and efficiency in conjunction with fostering students' motivation for reading.

In its current iteration, Reading Plus is designed to be used for reading instruction at a wide variety of levels and abilities throughout grades 3-12. However, the product is typically used for developing and struggling readers (Hiebert, et al., 2013). The product seeks to foster students' capabilities in the areas of reading comprehension, vocabulary knowledge, and fluency by bolstering word recognition and recall, teaching phonemic awareness, phonics, fluency, and supporting reading comprehension and analysis (Reading Plus, n.d.).

Theoretical Framework and Research

The research and consultancy team for Reading Plus includes reading experts Kristin Gehsmann, John Guthrie, Elfrieda Hiebert, P. David Pearson, Ralph Radach, Timothy Rasinksi, Ray Reutzel, and Jay Samuels, who have each contributed research in the field of reading in such areas as reading assessment, reading comprehension, vocabulary, motivation, and visual perception. Reading Plus's research is overseen by the director of research, Alexandra Spichtig.

The theoretical framework and research efforts of Reading Plus focus on four key, interrelated goals of the product: to foster students' reading confidence, interest, and motivation; to develop efficient reading strategies; to improve students' reading efficiency and speed; and to help students' ability to comprehend and synthesize text content.

The company's first focus is on three motivational domains of the students: self-efficacy or self-confidence, interest in self-improvement, and self-belief. Pearson stresses the

interconnectedness of efficiency, motivation, and comprehension as core facets of reading instruction:

> Efficiency goes hand in glove with motivation and comprehension. Readers need all three to be able to learn new ideas from books they read. Think of it as a combination of skill, will, and thrill. Efficiency provides the skill, motivation engenders the will, and comprehension leads to the thrill of acquiring new ideas. (Reading Plus, n.d.)

This link among efficiency, motivation, and comprehension is a significant piece of the framework and functionality of Reading Plus. Spichtig noted that in their research (Reading Plus, 2016) they have seen that inefficient students typically also have low reported confidence, which then has a strongly limiting effect on their effort and determination: “They're talking themselves out of interest. They don't even want to try because they don't think they can do it.” It is vital, she said, to help those students experience success as soon as possible so that they have confidence that they can succeed and then continue to strive to do so (personal correspondence, January 26, 2020). The Reading Plus team has seen a trajectory of students having higher self-improvement beliefs that boosts confidence, which then fosters interest in reading. This process is especially critical, she said, in the middle and secondary grades because continued struggles throughout middle and high school grades will eventually take away students’ self-belief and confidence:

> [In] third, fourth grade, they still believe that they can improve. They are so excited about being able to do a little something that they can still feel pretty confident in. [But] by fifth grade, you start seeing them tanking. It's really middle school and high school where that is super critical. Because by that time kids have struggled for a while [and] they may no longer have a lot of hope that things actually can change. My hypothesis is that actually the emotional burden is almost a tougher one to crack then the academic gap, because

you really have to help them change that story. (personal correspondence, January 26, 2020)

In response to the need to boost confidence, Reading Plus aims to show students that they can succeed by giving them a task each day or week that is attainable and then celebrating those achievements and "opening up that window of hope again." Spichtig notes, "Motivation is really something that is not an intellectual choice. It's really something that has to be experienced…it's really through helping kids experience change, and experience how they grow, and really celebrate that along the way, but making it in a way it's really critical that it's also real" (personal correspondence, January 26, 2020). The goals of showing students success and boosting their motivation are designed for students who are struggling, unmotivated, or unaccustomed to success, which is not the case with the students in this research study. Yet Reading Plus as a product is marketed for use with all student populations. It is important, therefore, to see how the features to boost motivation are used by the gifted student population since the fundamental goals do not apply to them.

To bolster students' reading interest, the product uses students' previous text selections to recommend new texts that might be of interest and includes other students' ratings of the stories. The product also provides cross-curricular recommendations, as Spichtig notes, "Somebody who thinks they're interested in sports [may] realize that actually technology is really what's exciting them as well. And through sport, we might be able to help them open up that little window" (personal correspondence, January 26, 2020). The recommendations and ratings are helpful both to engage reluctant readers and to help avid readers, such as those in this study, find content that match their interests.

The product's second focus is on the development of effective reading strategies, specifically helping students transition past decoding and the physical process of reading to taking in full words and then being able to focus on comprehension, synthesis, and efficiency. Drawing on Reading Plus's history in visual and aural testing, a portion of the company's research focuses on the connection of eye movements with reading efficiency. Their published data includes a study regarding the reliability of reading efficiency measures using Reading Plus's Visagraph system (Reading Plus, n.d.); a study regarding the correlation between eye movement data and three commonly used academic reading assessments: the Group Reading Assessment Diagnostic Evaluation (GRADE), the Reading Plus InSight assessment, and the SBAC (Smarter Balanced Assessment Consortium) (Spichtig et al., n.d.); and a comparison of eye-movement measures across reading efficiency quartiles (Spichtig et al. 2017).

Spichtig noted that too often students are too quickly moving to text that is too difficult before they have mastered decoding. Struggling readers and developing or beginning readers narrow their perceptual span and only focus on a few letters at a time, and if that becomes habitual, they become stuck in that transitional phase. "Students never get to transition [to] paying attention to a larger group of letters because they're so focused on looking at a couple of letters at a time and trying to decode the sounds and…putting the pieces together into words" (personal correspondence, January 26, 2020). Through their own research, Reading Plus has developed a proprietary spelling inventory that allows educators to group the students into five stages of literacy development and provide appropriate exercises for each.

The development of reading strategies comes in the eye-training section of Reading Plus, iBalance, which has two components. First, Reading Plus has an exercise that helps students focus on the physical process of navigating lines of text by replacing words with strings of

symbols. Second, the product helps students work on their perceptual and letter recognition skills through an exercise in which students see a plus symbol flashed with trigrams to the right and left. Spichtig explains the research behind this feature:

> Those three letters are based on real words, so we're not just randomly flashing letters, but we are actually using real word beginnings, because…as a reader becomes more advanced and just more efficient at reading, as words are getting longer, your fixation point…on a word is a little farther to the right of the word beginning. Ideally you want to center on the middle of a word but if the word gets longer, the tendency then is to start hanging to the left. So typically, you don't really go farther into a word than three letters. (personal correspondence, January 26, 2020)

The goal is to develop students' reading strategies to the point that they can then work on Reading Plus's third focus, reading efficiency. Students who are inefficient readers struggle to develop comprehension skills. Spichtig noted that the average speaking speed is 150 to 175 words per minute, which is past the transitional stage of reading and the reading speed goal for the students:

> [O]nce we actually get kids to at least that speaking range, then they are really going to make very significant gains in comprehension. And when I say to work on efficiency first, obviously we don't do that in isolation of comprehension. It's just that you want to really lower the difficulty of the texts that you work with so that kids get into the mode of being able to easily navigate that text, so they are not stumbling over a whole bunch of words that they can't instantly recognize. And also…we use texts that use large amounts of repetition so that they can really transition from decoding words to taking in words as entire units. (personal correspondence, January 26, 2020)

In the next section I will examine how Reading Plus incorporates these theories of reading instruction and learning into their product to support their key goals of fostering students' reading confidence, interest, and motivation; developing effective and efficient reading strategies; and fostering students' comprehension and ability to synthesize text content.

Product Features and Functionality

When students first use the Reading Plus product, they are required to complete an initial assessment using the Reading Plus proprietary assessment tool, InSight, which measures students' reading comprehension ability, vocabulary level, independent reading rate, and motivation (Reading Plus, n.d). The InSight process comprises three parts: first, the students read a 100-word selection and answer a series of literal recall questions, then they read a 300-word selection and answer a set of comprehension questions, and then they answer questions that test their vocabulary knowledge. The results of this process allow Reading Plus to create three reports: a screening report that specifies the instructional reading levels and reading speeds for the students; a placement report that recommends a personalized learning path; and a benchmark report that allows the teachers to monitor students' progress against goals (Reading Plus, n.d.). The company states that the InSight results can be compared with nationally normed standardized test results, such as the SBAC English Language Arts scores (Reading Plus, n.d.).

Once the initial assessment has been completed, the students continue on to three types of instruction tools that are assigned by the teacher or administrator: a reading instruction piece (SeeReader), a visual skills component (iBalance), and an integrated writing component. The SeeReader component has students read narrative or expository texts at their instructional reading level that was determined in the initial assessment. Reading Plus has almost 2,500 reading selections ranging from pre-primer to adult-level texts that are levelled using a

proprietary formula that includes Spache, Dale-Chall, and Fry readability formulas (personal correspondence, January 26, 2020; Rasinski et al., 2011). The vocabulary component of the Reading Plus lesson format teaches students key vocabulary words at each grade level (Rasinski et al., 2011). Reading Plus uses a proprietary list of 2,400 foundational vocabulary words that provide students with a basis to recognize and understand 10,000 high-frequency words that occur in complex texts across curricular domains.

Within the SeeReader portion, students read from a selection of fiction or non-fiction pieces that are at their level. Students read text in the Reading Plus Guided Window, which controls the amount of text visible and the students' reading paces, adjusting the paces based on the students' performance with comprehension questions. Reading Plus states that the Guided Window "makes reading comfortable by scaffolding the silent reading process, freeing up the mental energy needed for the ultimate goal of reading: comprehension" (Reading Plus, n.d.) At a certain level of reading ability, a student sees the Guided Window for the first half of the story and then does independent reading, which still controls the speed at which the student can read but it does not limit the text to a few words within a window; instead it shades the text in grey, line by line, at the set reading speed. A student may not click to go to the next page if they are reading faster than the set rate. Once a student has reached their grade-level rate goal, they have the ability to adjust their Guided Reading Rate (G-Rate) by increasing it or reducing it back down to their grade-level rate goal (Reading Plus, n.d.)

Once students complete a text selection, they are given an assessment that tests their comprehension and vocabulary through recall questions, comprehension questions, and cloze comprehension activities. If students correctly answer at least 80% of the questions, thus demonstrating their comprehension of the content and the ability to read at pre-determined,

grade-appropriate rates, they are able to move on to another story. Educators or administrators at the students' school can set the text and vocabulary difficulty and the reading speed as well as the requirements for how many lessons need to be completed within a given timeframe.

The iBalance component, described above, is designed to train students' eyes to read more efficiently and accurately by strengthening visual-perceptual skills and increasing eye movement speeds so that students can both quickly recognize several letters in parallel and easily recognize common letter groupings.

The smallest portion of the product is an integrated writing component that comprises writing prompts that students can access once they have completed a reading selection and scored at least 80% on the comprehension section. The prompts are related to the text selections and are assigned by the teacher. Reading Plus provides a rubric that offers grading criteria for development and organization, support and focus, and language and vocabulary.

To support students who are above level, Spichtig favors focusing on increasing efficiency to reach a reading speed of 250 words, at which point readers are taking in one word at a time, on average, she said. "If you're reading slower than that, then you're still engaging in some decoding. I mean we always do, a little bit…that's why I, personally, would keep students at grade level and just have them work more on efficiency development" (personal correspondence, January 26, 2020). She also recommends having students dig more deeply into themes and topics of interest in the text selections; for example they might use the text as a starting point and researching the topic or analyzing character development and interactions.

The research on Reading Plus showed it to be a high-quality instructional technology tool for reading, supported by robust research consultation with experts in the field of reading. Their focus on key aspects of learning to read, including comprehension, fluency, and vocabulary

skills, are supported by research in the field. Their concurrent focus on motivating students to raise their interest and engagement in reading is also consistent with research around student attitudes about and success with reading. Studies by Reading Plus, as well as independent studies, indicate the efficacy of their product.

In the next section I will examine the research results of my surveys, interviews, and observations with students to examine the efficacy and impact of Reading Plus with the specific student group of gifted students who took part in my study.

Part II: Gifted Students' Experiences with Instructional Technology

To determine if students in my research study experienced the intentions and implementations of Reading Plus as the company planned, I completed surveys, interviews, and observations of eight fourth-grade students using Reading Plus. The research results from these yielded eight major findings, each of which is listed briefly here and described in more detail within a narrative summary below. The first four findings are more generalized conclusions about the students' academic experiences and preferences that are relevant to this study because they are highly applicable within the setting of personalized learning in general and Reading Plus specifically. They are the following:

1. The students had high academic confidence.
2. The students stressed the importance of having an appropriate level of challenge in their academic work, wanting academic experiences that were neither too boring or simple nor impossibly hard.
3. The students had both intrinsic and extrinsic motivation, and they responded to rewards in a variety of ways.
4. Creativity and creative control was important to the students.

The second four findings are related to the students' feelings and preferences around reading and technology in general and within the specific setting of Reading Plus.

1. The students had unanimously positive views of reading.

2. The students stated that they had overall positive feelings towards technology in the initial surveys and interviews but offered more nuanced and mixed responses in later interviews.

3. There was not a clear consensus on the students' preferences for print versus digital formats in areas such as reading format (i.e. on a digital reader or on paper), tests, and instruction.

4. There was a diversity of feelings among the students about their preferences for interactions with teachers versus with computers.

In this section I will first give a brief overview of the demographics of the students in the study and then will examine and describe the eight findings in more detail.

Participant Overview

The eight students in the study were all from the school's two fourth-grade classes. They had been at the school for periods ranging from less than a year (1 student) to more than five years (3 students), with a median of 4 years and a mean of 3.6 years. The admission criteria for the school comprise a minimum score of 125 on the Wechsler Preschool & Primary Scale of Intelligence (WPPSI) or Wechsler Intelligence Scale for Children (WISC), teacher recommendations, grades or evidence of high academic aptitudes and performance, and the completion of a shadow day at the school, during which teachers, administrators, and the students themselves have an opportunity to evaluate the students' fit at the school. The tuition is approximately $23,000 per year, with financial aid available for up to 60% of the cost of the

tuition; approximately one-third of the families at the school receive financial aid. Taking those factors into account, the students who participated in the study were of generally higher socioeconomic status—as illustrated by their ability to pay the school's annual tuition and their access to and experience with multiple technology devices—had educational experiences and abilities that positioned them well for general academic success, and had a high degree of familiarity with technology.

Research Findings

The first set of findings relate to general topics of students' academic experiences, including their preference for challenge, the sources of motivation, and their academic confidence. I am starting with this set of findings rather than the findings specifically related to reading and technology because I feel it is important to describe the students' general abilities, preferences, and experiences before I look at their specific experiences with technology, reading, and Reading Plus. Further, many of these general findings closely relate to Reading Plus's theoretical framework and research regarding how students learn to read and have a direct impact on the students' experiences and preferences with Reading Plus.

Finding 1: Academic Self-Confidence

The first finding was that the students had high academic confidence. This was an important aspect to examine because the research on gifted students links academic confidence with motivation and engagement (Little, 2012), and building students' confidence is a major goal of Reading Plus. One of the key goals of the product is to help students who are struggling to find success quickly so that they can build confidence, which in turn will build interest and motivation and lead to more success (personal correspondence with Alexandra Spichtig, January 26, 2020).

The students in the research had high academic self-perception based on the Academic Self-Perception Survey (see Table 4), which uses a 7-point scale. The median response to four out of five of the questions for the group was a 6 (agree). The item, “I am confident in my ability to succeed in school” received a mean response of 6.3, indicating high academic confidence on the part of the students. The question with the lowest response was, “I learn new concepts quickly,” on which two students chose a 3 (slightly disagree) but still had a median response of 5. (See Appendix F for the complete survey text.)

Table 4

Academic Self-Perception Subscale (Derived from the School Attitudes Assessment Survey (McCoach, 2002))

	Student #1	Student #2	Student #3	Student #4	Student #5	Student #6	Student #7	Student #8	Median	Mean
I am confident in my scholastic abilities.	6	6	6	6	6	4	6	6	6	5.75
I do well in school.	7	6	5	5	6	6	7	7	6	6.125
I learn new concepts quickly.	6	3	4	3	6	4	7	6	5	4.875
I am successful.	7	7	6	6	5	4	5	7	6	5.875
I am confident in my ability to succeed in school.	7	7	6	6	5	6	6	7	6	6.25
Median	7	6	6	6	6	4	6	7		
Mean	6.6	5.8	5.4	5.2	5.6	4.8	6.2	6.6		

1 = Strongly agree; 4 = Neither agree nor disagree; 7 = strongly agree

In the interviews the students clearly indicated that self-confidence was important in driving their academic success, as seen in these two examples:

Interviewer: How confident do you feel at school?

Student #8: I feel very confident, also because my parents are always saying, "You do so well in school. I'm really proud of you." So, I get more confident every day.

Interviewer: How important is it to you to feel confident in what you're doing?

Student #8: It's really important to me because whenever I do something like acting or writing or reading or anything academic related, I'm always like, “I can do this, I can do this, I can do this.”

Interviewer: How confident do you feel at school?

Student #1: Pretty confident.

Interviewer: And how important is it to you to feel confident in what you're doing?

Student #1: Well, if you weren't confident, say you flunked a test or something and you had to retake it or something and you're like, “Oh, no, oh no, oh no, oh no.” Then you would probably just fail it again. If you weren't versus if you were confident and you'd be like, “okay.” And then you would retake it and probably do better.

Words such as “confident” and “important” frequently recur in these two quotes and are seen in bigger patterns throughout the students’ interviews. A point to consider in looking at the gifted students’ experience with Reading Plus, then, is, what happens when academic self-confidence is already high and the efforts to increase their self-confidence aren’t necessary or applicable? The alignment of student experiences such as that and the goals and features of Reading Plus will be analyzed in more detail, below.

Finding 2: Challenge in Academic Settings

Consistent with the research regarding the need for the appropriate level of challenging academic experiences within gifted education (American Psychological Association, Center for Psychology in Schools and Education, 2017; Little, 2012), my second finding was that the students agreed that their educational experiences should be hard enough to avoid boredom but not so challenging that they were impossible to accomplish. They strongly disliked boredom, saying, for example:

> I like school because if I'm ever sick, this is what I think, "I'm so bored. I'm bored out of my mind. Oh, my gosh. I should be at school, even though I'm sick and throwing up everywhere, but who cares? I'm so bored. I would rather be at school doing this nonfiction thing than sitting here watching TV."

On the topic of challenge, student responses indicated that they want the balance of a challenge but not a level of difficulty that is too high: "It's fun to be challenged, but it's just frustrating when they're challenging and I struggle with the more challenging tests," and "I don't want to be too challenged, because I want to have some challenge, but I don't want it be it like, `I've completely never heard of this or studied this, no'…it's achievable, but it has to challenge me." They overwhelmingly responded that they like challenges and are motivated to work harder to accomplish them. Student #7 commented, "I like [the assignments] to be too hard so I can be better at it… it's hard but it's possible, like everything's possible." The process of finding just the right level of challenge that is unique for each student is difficult even for the hands-on teachers who know their students well; it is exceptionally challenging for an instructional technology program to develop into an algorithm.

I tested the students' perceptions of and feelings about challenge while they were using Reading Plus, and they very clearly illustrated the theory that they wanted the appropriate level of challenge. In several cases, the students commented that the level of text difficulty, the speed of reading, and the level of the vocabulary words were too easy for them, and that was a source of frustration:

> Interviewer: Do you feel like it most often too easy or too hard, or on average it's OK?
>
> Student #4: Most times it's too easy. Like I literally had the word "click." And "button," like you press a button. Once I had "hair."

Interviewer: So, you feel like this feature is too easy for you?

Student #4: Yea. Once I had “tree.”

Like the student above, several students commented that the text, speed, and vocabulary were too easy for them. Before their second session using Reading Plus, I increased the text difficulty and reading speed for all of the students, then asked them to use the product again to see how they responded to the challenge. Student #5 was given a portion of Jack London’s 1903 story “The Call of the Wild,” and while he was able to understand the vocabulary, the plot was confusing to him, particularly the timeline and travels of the characters. He said, “The part when the dog was being traded between all the men was so confusing. I did not really understand…It was trading, trading, trading. And then for some reason he was still in San Francisco. I did not realize that.” The difficulty level of the vocabulary and the speed of the text, both of which I had increased from his first session with Reading Plus, were not too challenging; it was the text content that caused him to struggle.

Two of the eight students, both of whom had said Reading Plus was too easy for them, stopped reading the stories because they were too difficult, or the text speed was too fast, and they were unable to comprehend the text. In the case of Student #4, the text was the 1891 story “Luck” by Mark Twain, and she struggled with the story’s more complex figurative language, more complicated themes, and first-person narration, saying, “I don't know if it's starting yet. [Be]cause it says, ‘I’, I don't know if it's already started. I couldn't read the last part…because I was worried I'd miss a part or didn't get a part… I don't know [if] he's saying, `I’ as in the author, as in Mark Twain, or `I’ as in the main character of the story.” She was confused by the archaic and complex language, at one point looking up at me in shock and whispering, “I think it just

said something about a girl's breasts!" The sentence she was referring to was this, which comes at the end of the story's first paragraph:

> It was food and drink to me to look, and look, and look at that demigod; scanning, searching, noting: the quietness, the reserve, the noble gravity of his countenance; the simple honesty that expressed itself all over him; the sweet unconsciousness of his greatness – unconsciousness of the hundreds of admiring eyes fastened upon him, unconsciousness of the deep, loving, sincere worship welling out of the breasts of those people and flowing toward him. (Twain, 1892, pp. 66-67).

This 73-word sentence, which is at a grade 9.5 Flesch-Kincaid grade level, is representative of the language, length, and vocabulary level of the story overall, and her confusion with the text and complexity of the sentence is developmentally and academically appropriate for her level.

In the second case in which the student was unable to continue, the speed of the text was too high and the student was unable to keep up with the story. Neither of the two students who were unable to complete their stories seemed to be discouraged or disheartened by their inability to finish; they explained the challenge they had and moved on to the next task. Their body language was generally unchanged and they refocused on the task when we moved on to the vocabulary exercises. The point that Alexandra Spichtig made about students needing to experience success and still having the motivation to continue is apparent here. These students generally did well enough that a failure or challenge did not discourage them from continuing; they moved on to the next task.

The comments of the students support the research surrounding gifted students' need for academic challenge (Clinkenbeard, 2012; Dai et al., 1998; Gottfried et al., 2005), specifically

finding the areas in which they are challenged but not impossibly so. The questions around challenge ties in closely with the third theme, motivation.

Finding 3: Motivation

The theme of students needing a challenge ties in closely with my third finding, that while some students included intrinsic motivators, such as an inherent desire to work hard in school and be challenged, in their responses all of the students focused primarily upon extrinsic motivators, particularly good grades and parental approval. The theory of an inherently high intrinsic motivation among gifted students is common in the literature about gifted students, but there is much less research about extrinsic motivation in gifted students. The topic of motivation is key in this research, as it plays a large role in gifted students' experiences and performances, and student motivation is a major factor in Reading Plus's theory and functionality as the company focuses on motivation as a key driver in student success. Tying together gifted education research and Research Plus's focus on motivation, my questions for and observations of the students looked at such questions as, What motivates the students to work hard? Which goals are most important to the students: those that they set themselves or those that are set for them? How do rewards and supports influence the students' attitudes towards the work?

The students demonstrated strong intrinsic motivation in several themes that ran through their comments. First, several students noted that they worked hard in school purely because it was enjoyable, satisfying or interesting to them—"[working hard] just makes me feel happy," Student #6 said, while Student #5 explained, "[the schoolwork] is fun and it's the right level for me. So why not do what you can if you have the opportunity to?" Student #1 did far more work than he was assigned to do, often completing seven or eight stories and comprehension exercises per week instead of the assigned two, because he likes to read a lot of books, he said. The

students' motivation to work lessened when the work was too easy for them and became more rote an interesting, but almost all of the students spoke of their desire for challenging work and their motivation to complete it, not to achieve good grades or please teachers or parents, but because the work was satisfying in and of itself.

The second key theme that demonstrated intrinsic motivation was that the students were more driven by goals they set for themselves than by goals set by the teachers or parents, for example, Student #4 said she was most motivated by "Goals I set myself, because I know my limit…for example, at my old school, it wasn't very hard. We barely learned anything. Most of the time it's just party time." Another student said, when asked if she set goals for herself, "Oh, yeah. Even if it doesn't matter, but I like it, `Okay. I like this, so I want to do it, even though I've got to find time for it myself.'"

The third theme around intrinsic motivation looked at how the students felt about achievements, avatars, badges, and other rewards. The students were not motivated by unlocking achievements, for example, completing a certain number of comprehension tests above 80%. "I just don't care," one student said about unlocking achievements. "In video games when I have them, I just feel proud of myself. But when I have [achievements] in Reading Plus, I feel proud of them. I don't really think I'll just keep going and maybe I'll get more. I just feel proud that I've done them."

Similarly, the students were generally uninterested in rewards. As one student explained, "The best rewards are you knowing it"; another said, "I get allowance at home. That's my reward at home…Then like at school, my reward is something else, like just getting recognition or something." And this student felt that rewards were in fact detrimental:

Interviewer: Would you be more motivated to work on Reading Plus if there were rewards and they could be whatever kind of rewards you want?

Student #8: Probably not… I'd rather there be no rewards.

Interviewer: Why is that?

Student #8: I don't know. Probably because sometimes you could read too fast if you want to get a certain reward and you wouldn't pay attention as well.

Overall, the students did not want hints or help in their work—they saw such scaffolding as cheating or making the work too easy. In my initial conversation with Alexandra Spichtig, she mentioned that the students at the school do not usually use the ReReads function, which is a hint feature that shows the relevant passage of text to a student during the comprehension questions. The feature is popular among the students who are below level or struggling, and the Reading Plus team wondered why the feature was not used at this school. I asked the students how they felt about that feature, and the majority of them did not want to use it because it made it too easy: "I never need them," student #5 said. Or it felt like cheating to use them, as this interview indicates:

Interviewer: Do you know the ReReads? Have you seen that feature?

Student #4: Yes.

Interviewer: Do you ever use them?

Student #4: No.

Interviewer: And why don't you?

Student #4: I try to challenge myself, because if you use the ReRead, obviously in the ReRead you can just pick out the question without knowing what happened. You can just

pick it out. It says like, “What’s the parrot’s name?” Even if you didn’t pay attention to the story you can be like, “I’m guessing it’s Snappy, because that’s the only...”

Interviewer: It makes it too easy for you.

Student #4: Yea.

Interviewer: Do you have that ReRead button? In the corner here.

Student #1: Yeah.

Interviewer: Do you ever use it?

Student #1: No.

Interviewer: Why not?

Student #1: Because I don't feel like there’s a use to it because otherwise … then like it’s kind of like not from memory.

Interviewer: [S]o, is it kind of like feels like its cheating or too easy? Or-

Student #1: Well kind of too easy, because it’s kind of like giving away the answer.

Interviewer: So, it’s not challenging enough if you go and use that?

Student #1: Yeah.

The comments of these students support the research surrounding gifted students’ motivation by academic challenge (Clinkenbeard, 2012; Dai et al., 1998; Gottfried et al., 2005), specifically finding the areas in which they are challenged but not impossibly so; in this case, the use of the hint feature removed the level of challenge that the students needed to be fully engaged and challenged.

But the key finding around motivation that was more unusual and out of step with the literature on gifted education was the dominance of extrinsic motivators for the students. When

the students were asked, “Why do you work as hard as you do?” the initial answers were almost always focused on extrinsic factors, focusing on their drive to get good grades so they could get into a good college and succeed in a career or because they did not want their parents to get mad at them.

Interviewer: What's the main reason that you work as hard as you do?

Student #3: So that I don't get a bad grade.

Interviewer: What would happen if you got a bad grade?

Student #3: Well, first of all, then I might get sent back to fourth grade, and second, my mom will get angry at me.

Further, many of them saw hard work and success as the requirement for achieving something they wanted to do as an adult. For example, one student said, “It's usually when we work hard [that] we can get more out of what we want to do when we grow up. And if you want to be a scientist then you're obviously going to study a lot of math and science…so that's why I feel like we should work hard at something.” Similarly, “I think it's really important to get an education…before you do anything else. Like, say you want to be…a sport person or something like that, you need to get your education, too. Like, that's what a bunch of other people are looking for, too, for your job. Now, you need to get a good education, and they want you to be smart.” Another answered with a mixture of extrinsic and intrinsic motivation: “Because I want to get good grades. And also, classes would be more fun if you actually work hard, 'cause if you don't work hard then everything's not going to be fun. If you don't work hard, then you're just going to expect everything.”

Finding 4: Creativity and Creative Control

The topic of creativity and control is well-researched as an important feature for students in gifted education literature (Little, 2012; Rogers, 2007; Zimlich, 2016;). I asked the students several questions around the topic, including if they felt that they had enough creativity and control in their classes at the school, in their language arts class, and within Reading Plus. I also asked if they would prefer to spend time reading or creating. They answered overwhelmingly that creativity and control are important to them, and that they would like more of it. Two of them noted that one of their favorite classes is explore and create, a maker-space type of class, because it gives them the option for creativity without set instructions. As one student explained, "You get to create stuff and make things, and…there's not a certain way that you have to make it." Other students echoed that sentiment:

Interviewer: Would you like to spend more time reading or creating?

Student #5: Creating.

Interviewer: And what would you create?

Student #5: I don't know. I'm not too picky. I just want to create something.

Interviewer: Like writing or drawing or doing whatever.

Student #5: Writing, drawing, anything really. Artwork, weird crafts, slightly less weird crafts.

The two parts of Reading Plus that the students use—reading text and vocabulary exercises—do not involve creativity. The one piece on Reading Plus that does allow students an outlet for creativity is the writing component, which several of the students in the study said they would like to do, and, in fact, some work on that feature on their own even though their teachers had not assigned it and will not review or grade it. In this case the ability to do creative work lies

within Reading Plus and is at the teachers' discretion to assign it. The involvement of teachers in the interaction of reading and technology is beyond the scope of this study, but, as this shows, it would be an important and worthwhile future area of research, as they are a key actant in the role and experiences of technology in the classroom.

My second set of four findings focuses on the students' feelings towards reading and technology. My intention in asking these questions was to separate their broad feelings about technology and reading from their specific attitudes about Reading Plus.

Finding 5: Feelings about Reading

The first finding that came out of the initial survey and interviews with the students was that they had an unanimously positive view of reading. When asked, "Do you like to read?" on a 5-point Likert scale, both the students' median and mean responses were 4.5. In the interviews, when asked if learning to read was valuable they all agreed; for example, "I really don't need to answer that because every way, here, here, there, there. Even you reading the questions would be reading…And if you don't know how to read, it's…like reading and talking is half of your education." The students also felt that reading was helpful: "[I]f you read then you know what you should do to make what you create good and better than how you think it should be…Like, for example, if you're thinking about building a little barn, and then you read a story about a little kid making a barn and then he is making it better than how you think it should be, then that's giving you an idea of how you can make it better." None of the students had any negative comments about the reading process in general or their specific experiences with it.

I asked the students about the types of content they like to read and how they found books; for example, did they ask their parents or librarians for help in finding titles? Did they browse the physical shelves in a library, a virtual shelf in an e-book platform, or use Amazon's

recommendation engine? I wanted this information to help me see how the students felt about choice and discovery within their reading, which is a key theme within gifted research and a key aspect that Reading Plus has built into their product in order to support students' motivation and engagement with reading. As avid readers, the students in my study all had immediate answers to what they liked to read and how they found it, and several gave me detailed summaries of their favorite books. For example, Student 4 explained that she loves mysteries and told me about the most recent book she read, *Mistletoe and Murder* by British-American author Robin Stevens, which follows the investigations of two schoolgirl detectives, Hazel and Daisy, in 1930's Cambridge, England, who search for the murderer of Daisy's brother's friend over the Christmas holiday. She detailed the book's characters and plot twists with enthusiasm and excitement. Student #6 said she enjoyed a mixture of new fiction by such writers as Stuart Gibbs, author of the Spy School and Moon Base Alpha series, and classic book series that she reads with her mother, including Laura Ingalls Wilder's Little House on the Prairie series.

The students' methods for finding new books to read ranged from having their parents pick out books for them to browsing the shelves and pulling off books that were physically appealing. One student used the recommendations on Amazon at her mother's request. The majority of the students found books by physically browsing a library or bookstore rather than using ebook platforms through their libraries or online book sellers such as Amazon.

Finding 6: Views of Technology

My next questions focused on how students felt about using technology. My goal in asking these questions was to ascertain if they had negative feelings about technology outside of Reading Plus, as that would have an impact on how they interacted with the product and how successful they might be with it. Through the later interviews my next finding emerged: despite

giving the initial impression of having consistently positives view of technology, the students had much more nuanced and mixed views about technology.

I first asked the students a range of questions about technology, including what technology they have at home. The students in the study all had access to multiple technology devices, with seven out of eight owning an iPad, six owning a laptop, and six owning a video game console or device. Three of the students had an e-book reader and two had a desktop computer. Their universal access to technology removed the factor of whether any discomfort or unhappiness with technology was caused by a lack of access to or familiarity with technology.

When asked how they would describe using technology at home or in school, the students' responses were overwhelmingly positive, with the most common answers being "fun" (5 responses), "interesting" (2), "comfortable" (2), and "OK" (2). The full list of responses is in Table 5.

Table 5

What Are Three Words You Would Use to Describe How You Feel About Using Technology (at Home or at School)?

fun (5)	not too boring	good thing
interesting (2)	intriguing	great
comfortable (2)	happy	helpful
OK (2)	calm	cool
safe	learning	

The students gave overall high ratings for their comfort level with and enjoyment of technology. On a scale of 1 to 5, with 1 being extremely uncomfortable and 5 being extremely

comfortable, their level of comfort with technology and their enjoyment in using technology had the same results: a median of 4 and a mean of 4.4. One student ranked her enjoyment as a 2, substantially lower than the other group (and lower than her answer to her like of computers), and her negative feelings about technology came out in more detail in my interviews with her. When asked if they like to work with computers, the students' scores were a bit lower, with a median of 3.9 and a mean of 3.8. See Table 6 for more details. It is an interesting distinction that the students said they enjoyed using technology more than they liked to work with computers; was the difference in the verbs between the neutral *using* as opposed to the more loaded *working* with technology, or did the difference lie in *technology* (viewed more favorably) as compared to *computers* (viewed less favorably)?

Table 6

Students' Attitudes towards Technology

Likert scale 1-5, with 1 = Extremely uncomfortable/not at all, 3 = Neither comfortable nor uncomfortable/A medium amount, 5 = Extremely comfortable/A large amount

	Student #1	Student #2	Student #3	Student #4	Student #5	Student #6	Student #7	Student #8	Median	Mean
How comfortable do you feel using technology?	4	5	4	4	5	4	5	4	4	4.375
Overall, how much do you enjoy using technology?	3	5	4	2	5	4	4	4	4	3.875
Do you like to work with computers?	3.75	3	4	3	5	3	4	4.5	3.875	3.78

Within the interviews, the students gave more details about their preferences. In response to the question, "Do you like to work with computers, on a scale of one to five?" none of them fully endorsed computer use, and most cited a drawback to computer use. Student #2 mentioned several times that he has visual challenges while using computers and computer use "fries his brain." Yet he was adept with the computer, quickly and efficiently clicking through the Reading Plus product, pulling up Google to look up a fact he wanted to share with me and quickly

navigating to the information he wanted to show me. He skimmed the Reading Plus stories quickly, reading out loud and skipping rapidly from one part of Reading Plus to another without completing a story in the first session. He had high energy that kept him shifting in his seat and occasionally springing up from it to pace excitedly across the room as he explained something to me. When asked, “Do you like to work with computers?” on a scale of one to five, he gave a three, explaining, “I feel like it's because it's fun for me, but I also feel a little bit woozy when I do it.” I asked if it was a visual issue, and he replied, “It might be my vision, but it's even when I wear my glasses, I get a little bit woozy.” Two other students indicated that they liked the technology but identified drawbacks: “I think it's fun, but you shouldn't spend so much time on it. You should read books and do other things,” and “It makes it good because it’s a nice way to learn because sometimes I don’t know. It’s also bad because they can steal your personal information.”

Two students had positive views about technology and its influence on learning. Student #5 was eager, engaged, focused, and thoughtful as he answered my questions and worked with Reading Plus. In the second interview he stood and paced energetically during the interview as he answered questions. He showed no signs of frustration or nervousness when using Reading Plus or talking to me, and he was confident and curious on the product, enjoying challenges and looking for new experiences. He was neither rushed nor slow, focusing and working through the questions methodically. His views about technology, computers, and Reading Plus were unequivocally positive:

Interviewer: How do you feel about learning with technology?

Student #5: I very much like it.

Interviewer: Do you think school is a better place because you have technology?

Student: Definitely.

Interviewer: Do you think you learn better because you are using technology in school?

Student: The answer is yes, I do…because then we wouldn't have good websites, like Reading Plus.

Interviewer: Do you think technology changes the way you learn things?

Student: It's kind of different for the better. Like once you know more things, you know how to work with a computer better. You'll see it from a whole different perspective.

But other students were not as positive about the role and effects of technology in schools, as shown in these two interviews. One student said, “Sometimes technology can be a little bit funky” and was ambivalent about whether he learned better with technology, saying, “That could go either way.” Another student had a more complicated view of technology’s role in how students learn, with an idea of technology as damaging. This distrust of technology was a theme that emerged through several of the interviews:

Interviewer: Do you think that technology changes the way you learn things?

Student #8: Yes, because…you can basically almost do anything with technology, so I think you could learn a lot.

Interviewer: Do you think it's better or worse or just different, learning with technology?

Student #8: Different.

Interviewer: Are there ways that non-technology is better than technology?

Student #8: Yes, because technology could hurt your brain, and stuff that's not technology is better for you, but technology can teach you a lot more.

Student #4, who gave a 2 in the initial survey to the question of how much she enjoyed using technology, took a more negative stance:

Interviewer: How do you feel about learning with technology?

Student #4: I don't really like it.

Interviewer: Why not?

Student #4: Well, most kids do like it, but I don't really like it because I like more, better... It's hard to describe. I just don't really like it.

Interviewer: Do you think school is a better place because you're learning with technology or worse?

Student #4: Worse, because then you're just... I just don't like technology.

The nuances and complexity of the answers within the interviews, in contrast to the straightforwardly positive responses to the initial surveys, demonstrated two key points. First, the students' experiences with and attitudes towards technology are complicated and multifaceted; even while stating their enjoyment of it at a high level, they were hesitant, critical, and unhappy with it in other ways, and each saw its impact on learning differently. Second, a grounded theory qualitative methodology for the research is crucial to gaining a full understanding of the students' responses to the research questions because it allowed me to put together a very different picture than the one formed by the initial survey in which the students indicated high levels of enjoyment and comfort with technology. Through a series of interviews that dug more deeply into the students' comments I was able to build a more thorough and accurate picture of their feelings and preferences. A prime example of this is student #4, whose responses on the surveys were generally positive, including her description of technology as a "good thing," but who later was less positive about technology in the interviews.

Finding 7: Print vs. Digital Formats

The mixed response to technology carried over to their preferences for print versus digital formats in a variety of academic experiences: reading, exercises, and assessments. This group of questions was important because their preferences regarding format has a direct impact on their experiences with Reading Plus.

When asked for their preferred format for reading, four students said they would rather read in print and three said they had no preference; none cited a digital source as their preferred format. However, in interviews they gave more specific answers regarding their preferences, for example: "I prefer a book `cause I like turning the pages; I like getting into the book and waiting to read it." They described differences of experience in reading with digital or print, which are echoed in the tenets of New Literacy theory.

> Interviewer: Is it different when you use technology than when you use books or paper?
>
> Student #7: Yeah, because I kind of read fast, so sometimes when I click it on technology, it's like, you read too fast, I think.
>
> Interviewer: Do you feel like it's a different experience with a book if you read it on your Kindle versus if you read a print book?
>
> Student #7: Yes, it's different because…on the e-book you can do whatever you want with it, but with the book…you can't do anything with it. You have to leave it the way it was.

Relevant to reading format preferences, Alexandra Spichtig explained that Reading Plus's studies have found that it's harder to comprehend text on an e-book: "[Y]ou don't get that feeling or even that satisfaction of being halfway through the book. Because if you have a book

and it's open, you know where you are. So, it's easier to kind of organize the whole text in terms of the timeline of progression through the text" (personal correspondence, January 26, 2020).

Student #2 gave a 5 on the survey question of how much he enjoys technology but in a later interview he gave much more information, including drawing a distinction between "new" technology and "old" technology. He argued against the use of emails in favor of hand-written or typewritten letters:

> It's better to give someone a message than text them, because that means you care more about what you have to say to them, like ask them how you're feeling, that means you really care. You could tell them. Or if you're shy, you can go on a typewriter, click. You can just rip it out and then go...walk on the street. I'm going to walk on the street. Hand it out. You give it to them and you walk away.

This student had a complex view of technology, rating it highly and showing great adroitness with the hardware and software, yet citing his physical discomfort with it and his preference for an anti-technology device, the typewriter.

On the topic of taking tests on computers as compared to paper, the students were evenly split but had different reasons for their feelings. Student #2 said that he would be more nervous on the computer because of his physical experience and anxiety:

> I get more nervous when it's on the computer because also the way the pixels in the screen works, it also fries my brain a little bit. So, I'm thinking more about it but I'm looking at paper; I'm nervous. But I'm like "Okay, I got this." The pixels fry my brain. I'm like [gasps] and, "I got to do it." I don't think. I have time. I think I can do it. That's it.

Student #7 also said she would be more nervous taking a test on the computer rather than paper because "in general people can access them…and other people can find you," which

appears to be a concern focused on Internet safety and privacy rather than the experience of test-taking.

Student #3 said she preferred taking tests on the computer because she did not need to do as much handwriting, "[On the computer] you're not like writing, writing, writing and then instead you just have to push buttons," and because it makes her less nervous than taking tests on paper because of a stressful sense of urgency, "[With a test on paper] you know that soon you're going to have to turn it in and then you're like rushing, rushing, rushing, rushing, and if you're timed then you're really rushing." This is an interesting distinction because the tests taken on the computer, such as the NWEA MAP test, are taken during a timed class period just as written assessments and assignments are.

Fitting in with the research of New Literacy theory, in two instances the students perceived and experienced assessments in a different light because they were in a digital format. Student #5, who was the most positive about technology, did not consider tests in a digital format as a form of assessment at all, but more of an activity:

> Student #5: Paper tests are actually just a bit more nervous to me because I just think of like movies and TV shows…but like computer tests have… a different feel to them that doesn't make me nervous.
>
> Interviewer: Can you give me a little bit more information about the difference?
>
> Student #5: When I think of the word "tests," I don't think of computer. I think of paper tests during class, with the blacky thing like…
>
> Interviewer: The blackboard?
>
> Student #5: Yea, I also think of the three-sided square thing that blocks you from other civilization.

Interviewer: And then when you think of a computer test, what do you think?

Student #5 When I think of [a] computer test, “test” isn’t the word for it.

Interviewer: What would you call it? So, for example, the [NWEA] MAP test.

Student #5: Activity. For a computer test I'd really just call it an activity or a survey.

In a similar vein, Student #2 described taking an online comprehension test and printing it as a printed worksheet, making what he described as a “digital paper”:

Interviewer: How do you like doing [Reading Plus comprehension tests on the computer] as opposed to worksheets?

Student #2: Like compared to worksheets, this [Reading Plus exercises] is kind of ... to use a not really nice word, but this compared to a piece of paper sucks. Well, I had an idea. What would really work, instead you could go to a story, like these, I go to stories, and then you're going to click on one and it'd say, "Digital paper." Then you could print it out and then the sheets would come out.

This student, who voiced his preference for typewritten messages and “old” technology from the 2000s, such as earlier versions of the Nintendo video games, described and showed his familiarity and comfort with technology but consistently discussed his preference for processing materials in print; similar to his worksheet comment, above, in an earlier session he mentioned that he would prefer to print out the stories on Reading Plus and have them as a book and suggested that Reading Plus open a bookstore to sell their content.

Finding 8: Interactions with Teachers vs. Computers

In another example of changing experiences resulting from digital formats, some students found more judgment, criticism, and stress in working with teachers, while others found benefits, trust, and comfort with teachers instead of technology. These feelings of comfort and trust

towards technology versus humans is an important factor in considering the experiences of the students with technology generally, and specifically with Reading Plus.

In the case of several students, there was a sense of angry disapproval towards them from teachers and, conversely, a sense that there was no judgement on the part of computers. For example, “I would actually be more nervous taking [a test] on a piece of paper, because then I would know that somebody, a human, would be grading it. Because a computer, like, if you don’t do so well as you thought, the computer won’t yell at you, really. But I’m nervous taking a test really because I’m worried that the person is going to be like, `You did not do very good!’” Similarly, one student said that learning with technology is easier than working with a teacher, “Because it’s not like a teacher coming and saying, “You did this wrong,” and it doesn’t correct you as much.” Student #3 shared a similar view:

> Interviewer: How do you feel about learning with technology?
>
> Student: I like it because if you get an answer wrong, there's not somebody there to be like, "No, why did you do this wrong?"
>
> Interviewer: If the teacher were there, she would yell at you or get upset with you?
>
> Student: Well, kind of. Or it shows the bad grade that you got, something wrong that you did.
>
> Interviewer: Do you think school is a better place or a more fun place because you have technology?
>
> Student: It's a more fun place...Because then it's not only learning with teachers, learning with teachers. So that you can also do some things that help because technology actually kind of helps you learn a tiny bit better than teachers.
>
> Interviewer: Why do you think that?

Student: Because it helps you to know what you need to understand. Like on IXL [a math and reading website similar to Reading Plus], if you get a question wrong, then it starts to help you understand by making there be different questions that kind of relate to the question that you got wrong.

Interviewer: Do you think teachers do that at all or in a different way, or it's just not the same?

Student: They just do it in a different way.

Student #7 gave the most complex answer, which encompasses many of the contradictions of the print/digital discussion within the gifted setting: she doesn't like working with teachers because of the pressure, and yet she wants to earn the teacher's approval so that she can get a more challenging assignment.

Student #7: I hate working with a teacher. It gives me too much pressure…Only if it's something really easy, I would like to do it with the teacher because then I can impress them, and I get something really, really hard.

Interviewer: [T]hey would give you something hard to do because they would see how easy it was [for you]?

Student #7: Yeah.

The other group of students within the sample found the experience of being graded by Reading Plus a more negative experience than working with teachers. Student #6 described the impersonal grading of Reading Plus's green, yellow, and red symbols as demotivating:

Student #6: I also don't like how it gives you…grades and stuff: "You didn't read well, so you have a 65% out of 100, and now you're in the red zone."

Interviewer: Does that make it more or less likely that you would keep going and try harder? Does it make you motivated or unmotivated?

Student #6: Demotivation.

Interviewer: And what if you had that same experience on paper with [your teacher]? What if you took that test on paper and you got that grade--would it feel different? Would it be a different experience?

Student #6: Uh-huh (affirmative).

Interviewer: Why is that?

Student #6: 'Cause it's not on a computer that's has more intelligent life than you, and it won't go like, "Oh, you did horrible."

She later continued on the idea that Reading Plus was demotivating:

Student #6: I just feel like [Reading Plus is] taking away my information and my brain.

Interviewer: How are they taking away your brain?

Student #6: By discouraging my mindset.

Interviewer: How are they discouraging your mindset?

Student #6: By telling me I spelled it wrong. And then I have to work and get five more questions to earn that five points again. And at this rate I'll never finish one lesson and stuff like that.

Student #6: Reading Plus is a smart aleck.

Interviewer: Why do you say that?

Student #6: Because if you spell something wrong, they're like [in a deep, sarcastic tone], "Yeah, that's the wrong answer."

Interviewer: Do you feel like they're judging you? You said that in a funny voice like...

Student #6: Yeah.

The final theme that emerged in the students who voiced their dislike of Reading Plus was that they felt that the product was trying to trick them, or intentionally trip them up by offering incorrect answers. In this case, Student #4 was describing the vocabulary exercises on Reading Plus:

> [M]ost of the time I don't think what the words sound like, because that's the thing, they try to trick you. So if something said, "compostation" [sic] and you think, "Oh, compost, is…" and then you clicked like, "dead matter for compost," that's what they do, they do similar words to they make you think, "Oh, it's probably this, a cinnamon [sic] for compost…did I just say cinnamon? I meant synonym."

The idea that digital content is less trustworthy also came through when the students talked about reading on a digital device; two students commented that an e-book or digital version of a text could be changed, whereas a print version of a text could not. For example, Student #4 said, "When it's on a Chromebook I keep thinking that something might be changed maybe…because normally people don't write a story on Chromebook, mostly they write it on paper, I think. So I'm worried that…the person who wrote it on the Chromebook after might change something." The idea of the permanence or trustworthiness of print materials versus digital materials emerged at several points in my interviews with the students.

The surveys, interviews, and observations provided a picture of student experiences and preferences that were complex but generally consistent with the theories of the research as detailed in the literature review. Consistent with the research on gifted education, these students valued control and creativity and sought the optimal level of challenge. This specific group of

research participants had highly positive views of reading and generally positive views of technology in initial interviews and surveys but much more complex views and preferences in later conversations. The differences in experiences and preferences regarding print and digital media and experiences related to technology in general were consistent with the theoretical constructs of New Literacy theory and critical technology theory, as I will discuss in more details in the analysis in Chapter 5. In the next section I will examine how well the understandings and implementation of Reading Plus aligned with the preferences and experiences of the students in the study.

Part III: Comparison of Developer Understandings and Student Experiences

An analysis of Reading Plus's research, theoretical frameworks, and features and functionality show that they are rooted in best practices and a strong tradition of high-quality research and consultation with subject experts. There is significant alignment with the needs and preferences of the students in the research. However, some of the company's implementation of research does not align with gifted students' preferences and experiences in areas in which gifted students differ from the typical student population, specifically in areas of motivation, perceived challenge, and academic confidence. In this section I will examine how Reading Plus's features and functionality matched the preferences and performance of the students in the study. An overview of the themes, how Reading Plus incorporates them, and how the students experience them, is shown in Table 7 and discussed in more detail below.

Table 7

A Comparison of Reading Plus Features and Gifted Students' Typical Preferences

	Reading Plus's features and functionality	**Gifted students' needs/experiences and match with Reading Plus**
Pre-reading	Minimal pre-reading offered; only brief story description and illustration	Students need and would like pre-reading support in cases of higher-level texts that have challenging themes **Good match but additional support in activating students' schema and teaching them relevant vocabulary for the story would help for more advanced texts**
Decoding	Offered minimally; Reading Plus has moved away from decoding towards focus on comprehension and fluency	Not needed at this level; students illustrated advanced decoding skills **Excellent match**
Word recognition	Key feature with the product	Students' word recognition skills are high but can be further developed for more advanced vocabulary, especially vocabulary from classic literature **Good match but tying in vocabulary from more advanced texts would be beneficial, particularly with texts by such authors as Cervantes, Poe, and Kafka, which have rarer and more arcane vocabulary terms and unfamiliar morphemes**
Comprehension	Key feature, but no further support or scaffolding given to student if they lack comprehension of more advanced texts	Needed for more advanced vocabulary and complicated textual themes **Good match but additional support would help for more advanced texts**
Fluency and speed	Key feature	Needed: Most students are reading at the target speed of 150 to 175 words per minute, but not quite at the goal for middle school (their texted Lexile level)

		of 250 WPM; tools and exercises support fostering speed improvement well **Excellent match**
Motivation and engagement	Aligned with research and norms for student motivation, but largely geared for below-level or struggling readers	Motivation and engagement are key to success, but motivating factors are different for above-level students than for struggling/below-level readers **Good match but could be more closely correlated to unique student needs, which include a desire for challenging assignments and limited supports that make the work seem too easy for the students; the students in this study already had high motivation, engagement, and a love of reading, so the tools that Reading Plus has to foster those are unnecessary (but not detrimental) for this student population**
Universal design for learning	Works towards best practices in areas of accessibility, control, meaningful experiences, product research	Challenges come in considering student capabilities based on age and development, which can be asynchronous **Good match**
Challenge	Aligned with research and norms for appropriate level of challenge, but largely geared for below-level or struggling readers	Challenges are very important at this level, but to keep the challenge level high students are introduced to more complex, classic texts, which they struggled with **Good match but more advanced stories require additional support**
Choice	Offered in story selection and recommendation tool	Very important **Good match, but students would like more options within each level**

Reading Processes and Theories

Reading Plus addresses the majority of reading processes and theories discussed in the literature review. Their theoretical framework falls in the cognitive and linguistic side of the spectrum shown in Table 1. Reading Plus utilizes information/cognitive processing theory, which studies the cognitive, internal mechanism and mental tasks in reading. It also follows structuralist theory, which examines print perception, such as reaction time, lip movements, or reading speed (Yang, 2018). Reading Plus also uses reading motivation theory with the guidance of one of the main scholars in the field of motivation and reading, John Guthrie, who serves as a consultant for the company. Motivation theory examines intrinsic and extrinsic motivations for reading as well as students' sense of self-efficacy and the impact of that on their success (Guthrie et al., 2007; Guthrie et al., 2013).

Reading Skills and Instruction

A comparison of Reading Plus's support of the five key reading development skills examined in the literature review and shown above—pre-reading, decoding, word recognition, comprehension, and fluency and speed—with the needs of gifted students shows an overall good match.

The product offers limited pre-reading opportunities beyond a summary of the story and related image, which is sufficient when the students are not challenged by the text, but it is inadequate when they need extra explanation or scaffolding. For example, when the students read more challenging works, such as stories by Twain or London, they needed more pre-reading and scaffolding to understand the complex themes. Once the students were unable to complete the story, there was no support or explanation for them, which was frustrating to some who wanted to understand the story but not to others who simply wanted to move on to the next task.

Reading Plus puts limited emphasis on decoding skills and much more focus on word recognition tools and comprehension exercises, which is appropriate for the typical skills and needs of this group of students. I asked the students how they decoded the words that were unfamiliar to them, and they clearly explained the process. For example, student #5 explained, "I can think of the different parts of the word…I would distinguish it from there. Like Roman stuff, like for `luminate,' like light and stuff," and student #1 said, "I tend to sound the word out because sometimes it may have the definition in the word."

Reading Plus puts a high value on developing fluency and speed through various visual skills exercises. The students in the study, however, did not need the visual training exercises and they were able to select independent reading (i.e. reading without the guided reading box) because their reading speeds were high enough.

As illustrated in the cases of motivation prompts and visual exercises, some of the features of Reading Plus are not needed for above-level students such as those in this study. When asked about how the site does (or should) support above-level readers who are at a high levels of efficiency and comprehension, Spichtig notes that those students do not generally need the guided window: "The guided window is…used for a very specific purpose. [I]t's really meant to help the students that are not just naturally developing good habits, because we have lots of students out there that are reading efficiently, and they never used a guided window. The guided window is really meant to help model what efficient, silent reading looks like while eliminating the potential for bad habit development" (personal correspondence, January 26, 2020). The inclusion of unnecessary features for this group of students, such as eye-training exercises, is redundant and not damaging for them in contrast with the exclusion of needed features, which in

the case of the student participants includes some additional scaffolding for the more challenging texts.

Student Motivation, Engagement, Challenge, and Choice

Reading Plus puts a high value on fostering and maintaining students' motivation in reading by designing the product and the students' experiences with it to boost their success, which, in turn, boosts their motivation. As motivation is a key aspect of gifted students' experiences, this would seem to be a good alignment of product design and student experience. However, the students in the study already had high academic intrinsic motivation and desire to read. While those features on Reading Plus were not a detriment to the students' experience, neither were they an enhancement; they were simply irrelevant to the students.

The level of challenge in the product was good, and there were stories that were very challenging for the students. This was a good match in terms of the students' needs, but the functionality of Reading Plus fell short in providing scaffolding and support when they needed it. The students were intrigued by the classic texts by Twain and London, but they struggled with some of the language and themes and did not receive support within the product to help them, thus putting the story out of their zone of proximal development. In the case of gifted students, therefore, the level of challenge was good, but the lack of scaffolding was problematic.

The students thought there was a fair number of choices among the text selections in the stories, but several students commented that they had been kept at the same level for a second year in a row and thus were reading the same stories as in the previous grade. For the cases in which the students were above their target achievement levels, the teachers could have moved them up, and based on the performance of the students when I did move them to a higher level, they would have succeeded at the higher level. This is an excellent illustration of the need for

teacher involvement with the technology tool to ensure that the benchmarking process is accurate and that the technology is moving the students along at the right pace.

Product Design

Reading Plus's product design generally meets the best practices for universal design for learning in the areas of accessibility, control, meaningful experiences, and product research. The product protects the students' privacy and offers options for accessibility for students with special needs in compliance with the Americans with Disabilities Act. By striving to motivate and engage the students, Reading Plus seeks to provide meaningful experiences, and their product research is robust and of high quality.

Summary

The research and details provided by Reading Plus, and the responses of the students regarding their experiences with technology tools in general and the product in particular, are consistent with the relevant literature regarding instructional technology for reading and gifted students, respectively. Both the initial set of findings—regarding confidence, challenge, motivation, and creativity and control—and the second set—regarding their views of technology, reading, preferred media, and working with teachers or technology—matched well with the expectations from the research and theoretical frameworks. The importance of challenge and creativity were clear in the students comments, and the students showed high levels of confidence and a love of reading. The misalignment with the features of Reading Plus occurred where the product was focusing its development and implementation on the abilities and preferences of struggling and below-level readers rather than above-level readers. For example, Reading Plus focuses development on features that would support students' motivation, confidence, and engagement, which is not a need for gifted students, who generally have high

rates of success, academic confidence, and motivation in their work. While their product is primarily used by and therefore tailored for below-level and struggling readers, it is marketed broadly, as a truly personalized learning program that can meet the needs of all learners.

In the next chapter I will look at these findings through the lenses of the theoretical frameworks of New Literacy theory and critical technology theory to determine how these theories might explain the differences, similarities, and divergences of my findings with the literature and research to date.

Chapter 5: Interpretations, Discussion, and Recommendations

Introduction

The purpose of this qualitative grounded theory study was to use the frameworks of critical technology theory and New Literacy theory to see if and how the specific subset of gifted students experienced personalized learning for reading in ways different from designers' intentions and understandings. Through a series of informational conversations with research and product development staff at Reading Plus, as well as in-depth analysis of their research, I was able to understand how that product has been built for reading instruction. I then used several qualitative measures to gather details of the students' experiences, preferences, and opinions on a range of topics around reading and technology. Finally, I compared the developer understandings and implementation with the students' experiences and preferences. In the previous chapter I looked at three sub-questions:

- What assumptions about how the reading process works at different developmental stages do software developers make in building personalized learning programs for gifted students in terms of the reading process, student abilities, motivation, and preferred types of engagement?
- What do gifted students think about their experiences with personalized learning software in terms of whether and how it aligns with how they prefer to learn and engage with instructional technology?
- How do the developers' assumptions and understandings match the students' self-reported reflections on their experiences using personalized learning software?

In this chapter, I will synthesize the specific findings from chapter 4 within the two theoretical frameworks of critical technology theory and New Literacy theory to draw

conclusions regarding the main research question: *How do personalized learning programs' instructional designs match gifted students' experiences in using them?* I will then pose recommendations for the broader educational field based on the analysis and I will provide my recommendations for future research in the area of this study.

Analysis of Findings

My data demonstrated that Reading Plus is a superior example of a personalized learning tool for reading instruction that is most commonly used by, and therefore primarily tailored for, struggling and below-level readers. The company's use of expert consultants and researchers, as well as Reading Plus' theoretical framework, understandings of the reading process, and implementation of those concepts are high-quality and effective for a substantial portion of the student population. A key point to remember, however, is that the product is marketed for use with all levels of readers, and so it is positioned as a truly personalized instructional tool. When educators and administrators are considering the purchase and use of the product, they might not have access to data or information that shows the strength of the product with lower-level readers and the potential mismatch of features and functionality with the needs of above-level and gifted readers.

Consistent with the research regarding gifted students, the student participants overall were academically confident and valued challenge, choice, and creativity in their schoolwork. Their stated motivational factors were largely extrinsic—good grades and parental approval—but they had strong intrinsic motivation as well, as evidenced by their lack of interest in the software-provided hints and scaffolds, which some deemed made the work too easy. The students were largely positive in their views of technology and reading, and their comments about Reading Plus were generally favorable. The features of Reading Plus are overall a good fit

with the experiences and needs of the students in the study, though there was additional support needed for the students in the areas of pre-reading and comprehension for more challenging texts, and the students had a different focus in the areas of challenge and motivation.

The student participants comprised a generally homogenous group in terms of their educational backgrounds, academic levels, and socioeconomic statuses. It would seem logical, therefore, to assume that they experienced instructional technology for reading with more similarities than differences. However, after talking with them in more detail, it became clear that their experiences, preferences, and understandings of technology in general and instructional technology for reading in particular were quite varied. For example, some students, such as Student #5, found technology to be helpful and fun, while others, such as Student #4, found it to be tricky and a "smart aleck." The students' preferences in formats for reading and taking tests varied widely, as did their preferences for getting tests scores and grades from either a teacher or a computer program.

New Literacy and Critical Technology Theories

The theoretical frameworks of the study provide an explanation for differences in experiences that underlie the mismatch between product implementation and the students' experiences. First, we can use the ideas of New Literacy theory to examine how the process of learning with technology has changed from the experience and processes of learning with a static print work and how the interaction of the child with that work has changed. Leu et al. (2011) argue that change is constant and endemic in digital tools and content that are used in reading, and for that reason literacy itself is deictic. Students notice constantly changing texts and differences in formats. This theory can help shed light on the question of why the digital texts seem untrustworthy to some students in the research study because they are manipulatable; as the

students remarked, “Sometimes on a piece of paper, it's different than what it is on the [digital] thing. Sometimes the websites gamble it up a bit,” and, “On the e-book you can do whatever you want with it, but with the book...you can't do anything with it. You have to leave it the way it was.” While these opinions might not have a strong impact on their academic performances, they will have an impact on their experiences with the texts.

Through its focus on text layout and appearance in the experience of reading on a screen, New Literacy theory can explain the specific differences in this study of the students’ experiences with text and assessments on screens versus paper. Student #2 was uncomfortable with text on the screen and wanted to print out the stories and exercises, although he did not view that action as simply making print versions of the digital pieces; instead he considered them a hybrid digital/print piece that he named a “digital paper.” Leu et al. (2011) wrote that reading comprehension is one changing area of literacy because online reading comprehension differs from print reading and requires additional practices, skills, and strategies. For example, Leu et. al (2011) cited three studies that found significant differences between students’ performances on measures of offline and online reading comprehension. These led the researchers to ask what “skills, strategies, and dispositions” the students need to read in a digital environment and how they would obtain those skills (p. 5).

Finally, New Literacy theory helps to explain the differences in preferences for the guided reading window within Reading Plus, which limited the students’ views to a few words and dictated the speed at which they read. One student felt that the guided reading window improved her comprehension: “I think [the guided reading window] made me more comprehensive [sic], like I can understand better now”; another felt that it increased his reading speed: “I like the window so I don't speed up really fast, but I like reading to my own level

because sometimes I read faster than other times." The skills and preferences needed to process the text using a guided reading window are different than reading on paper, which has no constraints regarding the students' ability to skip forward and backwards on the page, skim through a chapter or book, and read at any desired speed.

Rosenblatt's reader-response theory reminds us about the importance of seeing how the reading process is deeply personal and individualized, leading students to look for texts that they relate to personally. Tying the broader theme of different experiences in reading and technology in with Rosenblatt's transactional theory can help to illuminate how and why students make choices. For example, these two interviews illustrate different personal reasons for the students' choice of their text selections:

> Interviewer: Do you remember the last thing you read on Reading Plus?
>
> Student #4: Yea, I forgot the title but it was about parents getting divorced because my parents are divorced. I was just wondering if it's normal. They didn't say if it was normal. It was kind of fiction-y, like fiction. It was about a girl whose parents were divorced, and they found a way to come together because she had to keep going, and over the story a year passed through the story.
>
> Interviewer: Did you like it?
>
> Student #4: Yea, I guess. I didn't really find my question, though.

> Interviewer: Could you choose either fiction or non-fiction? How did you choose?
>
> Student: #2: I went to action and adventure and then I clicked on fiction because I really like fiction. Because most of them are Greek mythology so it helps me with my Greek.

The academic abilities of these two students as demonstrated by their vocabulary and their comprehension levels are similar. Yet the life experiences, personal interests, and academic concentrations of these two students lead them to select different content and information. Through its emphasis on lived experiences, critical technology theory looks at how these details get overlooked or disregarded because technology in schools disregards the influences outside the classroom. Selwyn (2011) argues that the "lives of current generations of technologically attuned students are seen to be entwined with new cultures of digitally-based creativity, collaboration and community" (p. 30), but there is a disconnect between the technology used within school and outside of it, with school technology limited to pedagogically marginalized, rote uses that are granted limited resources, relevance, time and support within the school setting. The implementation of technology in school does not reference or relate to the students' lived experiences and preferences, resulting in misalignments between students' diverse needs, preferences, and abilities, and the implementation and use of the technology.

Challenges of Reading Instruction within a Diverse Student Body

The diversity of opinions and preferences just within the small sample of students in the study can be seen as a microcosm of the presence of varieties and differences within the student body of the United States. The K-12 student population in the United States was approximately 58.2 million as of January 2020, with a wide diversity of students in every demographic aspect. For the first time as of the 2015-2016 school year, White students no longer comprise the majority of the school population; they comprise 48.2% of the student population; LatinX students comprise 26.4%; Black students 15.3%, and Asian students 5.1% (Riser-Kositsky, 2020). The percentage of public-school students in the United States who were English Language Learners (ELLs) in fall of 2016 was 9.6% of the total student population, and they

spoke more than 400 languages (Bialik et al., 2018). For the 2018-2019 school year, 14% of the total public-school students—7 million—were served under the Individuals with Disabilities Education Act (IDEA), with 34% of them receiving services for specific learning disabilities (The Condition of Education - Preprimary, Elementary, and Secondary Education - Elementary and Secondary Enrollment - Children and Youth With Disabilities - Indicator May (2019), 2019). This small sample of the diversity within the student body does not touch on the variations within less statistically definable aspects of the students: the students' lived experiences; their educational backgrounds; their personal interests and motivations. All of these features influence the students' journeys, preferences, and experiences through school.

The differences and complexity uncovered just in this study's students' responses and preferences highlight the challenges and dangers of using broad generalizations of student abilities, aptitudes, and needs in developing and selecting pedagogy and content for students. The use of generalities and oversimplifications raises a high risk of a mismatch between product and student needs and performances in any educational setting. As this research has shown, even a high-quality instructional technology tool cannot meet every need of every child, and specialized groups such as gifted students bring new challenges to the process of finding a good educational match. This research illustrated the challenge of introducing technology as a leveling factor that would in theory address a wide variety of needs and abilities. The study highlighted the particular differences in how technology was experienced, used, and perceived by a group that differed from the norm.

The Interrelationship of Technology, Students, and Reading

The three core components of the equation of instructional technology for reading—the texts, the students, and the technology—are intricately linked and interconnected. Each

component influences and is influenced by the others, as shown in Figure 2, which depicts the commonly perceived but erroneous representation of the relationship among the three components. This basic representation assumes that each component has equal weight and that there is homogeneity within each component and an equal relationship among the three.

Figure 2

Inter-relationship among Technology, Reading/Text, and Students, Version 1

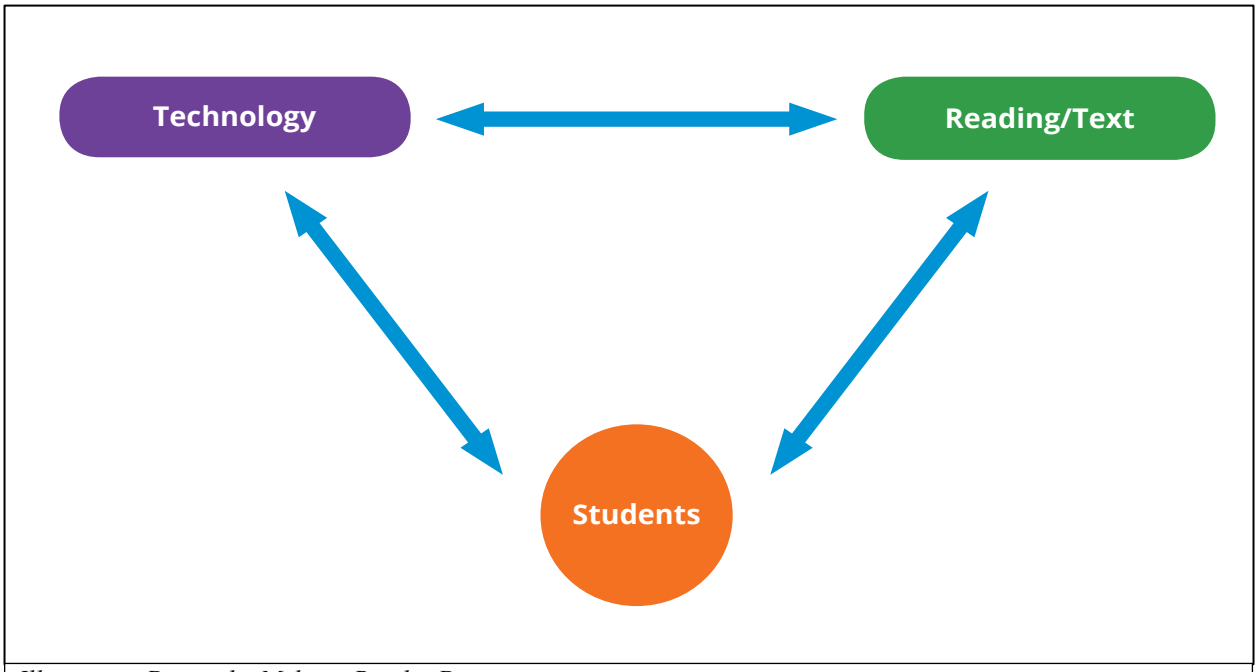


Illustration Design by Melanie Bender Design

The most important component of this relationship is the students themselves, who are represented in this diagram as a single, unified entity. That is arguably the most dangerous—and yet the most common—assumption, that the students can be treated as a uniform group, whether that means using the same pedagogy, content, assessments, or other educational materials. In fact, the diversity, differences, uniqueness, and individuality of students make it impossible to

draw a single box for them. My research on just eight students at one specialized school showed the differences that exist among children. As one student described himself and his peers, "One of the good, cool, and definitely normal things about gifted kids is that they're all different...Because for gifted kids, being different is normal." One could accurately omit the word *gifted* and the sentence would apply globally:

"One of the good, cool, and definitely normal things about kids is that they're all different...Because for kids, being different is normal."

Education leaders—creators, consumers, instructors, and evaluators—should remember that sentiment in the context of educational technology. A more accurate revision to the diagram, then, would be Figure 3, which shows students in numerous boxes to indicate their differences and uniqueness, all interacting with technology and reading/text.

Figure 3

Inter-relationship among Technology, Reading/Text, and Students, Version 2

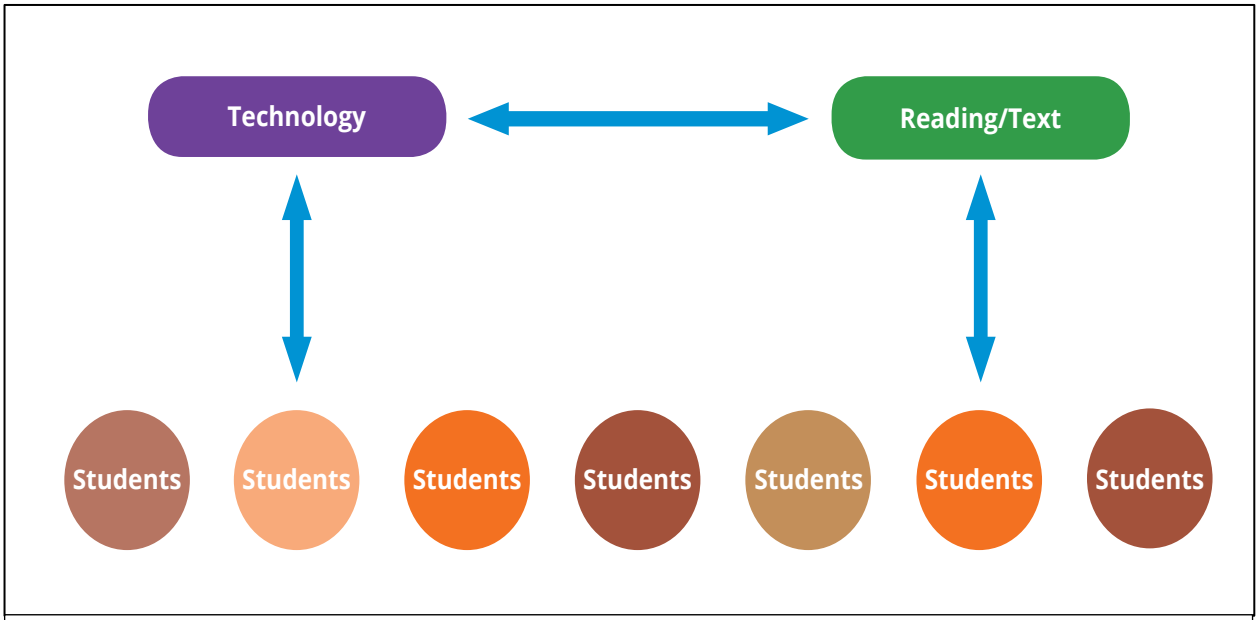


Illustration Design by Melanie Bender Design

But this representation also fails to accurately depict the interrelationships, by erroneously depicting a single entity for technology and for reading/text components as well as inaccurately showing a single influence of technology and reading/text on the students themselves. New Literacy theory shows how technology and reading have broken apart into multiple versions, aspects, and experiences, and are constantly changing. Leu et al. (2017) note that the existence of multiple technological contexts and diverse social contexts has resulted in a multiplicity of literacies, which are themselves multimodal and multifaceted. Critical technology theory shows how external forces, varying from socioeconomic status to issues of equity and access, lived experiences, and viewpoints, have a strong impact on student experiences.

Considering those additional influences, a more accurate version of the diagram would reflect the changes, fluctuations, uncertainty, and inconsistency brought by external forces that stretch, strengthen, weaken, and mitigate the strength or dominance of one factor over another. Figure 4 shows the complex and messy dynamic that is the reality of the interrelationship among technology, reading, and students.

Figure 4

Inter-relationship among Technology, Reading/Text, and Students, Version 3

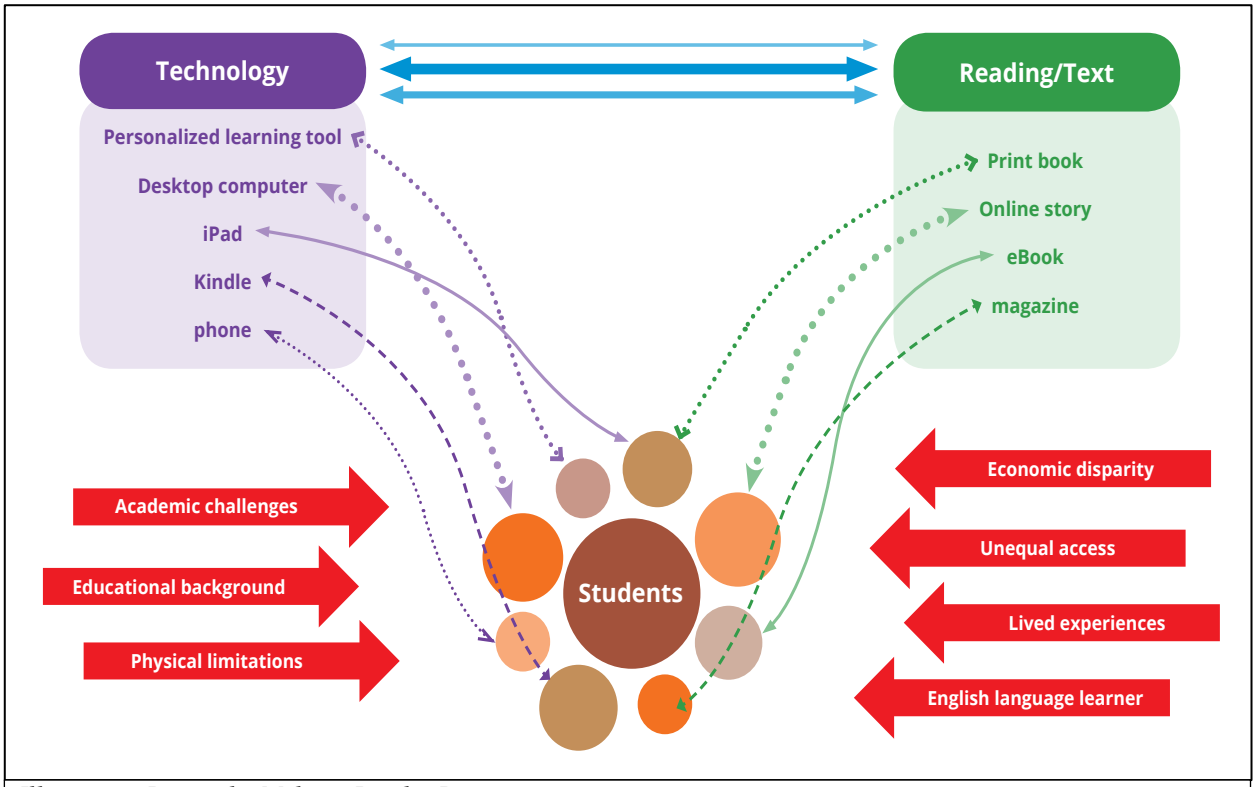


Illustration Design by Melanie Bender Design

Examples of technology include personalized learning tools such as software, websites, apps, and other instructional technology, as well as hardware such as a desktop or laptop computer, iPad, or phone. Examples of reading and text components include print works such as books and magazines, as well as digital texts such as e-books or an online story. Technology

influences reading and texts by introducing changes in formats, presentation, functionality, and content through digitization and delivery in non-print media; literacy and reading are deictic as a result of the speed of technological advancements. On the other side of the relationship, reading and text influence technology because people seek to access text in new ways—on electronic devices, prompting the creation of e-books, Kindles, and e-readers; or to have extra features, such as weblinks, videos, and embedded dictionaries. Leu et al. (2017) describe the "envisionments" that we construct as we use new technologies to create new social practices: "Envisionments take place when individuals imagine new possibilities for literacy and learning, transform existing technologies and practices to construct this vision, and then share their envisionment with others" (p. 5). The mutual impacts that technology has on reading and texts and the impact of reading and texts on technology have created a complex and rapidly changing dynamic; even the definitions of technology and literacy are constantly in flux. To illustrate this, the relationships between reading/text and technology are represented in this diagram by multiple lines of varying weights.

The students in Illustration 4 are represented as varied and unique, and their relationships with each of the technology and reading/text components are distinctive and individual. Their interactions with technology and reading or texts are influenced by such decisions as how and why they choose a piece of text and how they interpret it, what their experiences with technology are and whether they had academic success or struggles with it, and how it affected their learning experiences.

The final component in this complex relationship is the external factors beyond the technology and text that are influencing the students, from academic challenges and educational backgrounds to economic disparity, unequal access to content, tools, or other educational

components. These factors influence the students by changing their experiences, outlooks, and preferences, which then have an impact on their selection of, and interaction with, the texts and technology. Many external dynamics, such as access to and training with technology, English language ability, and physical and academic challenges, have an enormous impact on the students' abilities to use the technology successfully and in the way intended by the technology's developers and the students' educators. For example, Leu et. al (2014) found that income inequality resulted in a significant achievement gap in online reading more than offline reading.

The complexity of the relationships shows the underlying reasons why students' experiences and preferences are so varied, it highlights the urgent need for educators, administrators, and curriculum developers to consider all of the factors, not relying on a Lexile score or an algorithm that ignores the impact of so many other weights and influences.

Implications for Personalized Learning Tools for Reading

Personalized learning tools have a large current capacity and even greater potential to help educators meet the needs of the diverse student body, adapting content, pedagogy, assessments, and tools of the classrooms for myriad student needs and preferences. As instructional technology's algorithms become more complex and nuanced, and as artificial intelligence becomes more effectively refined and specialized for educational implementations, the impact and success of personalized learning tools will increase. As illustrated in this research study, there are three areas in which personalized learning tools for reading need to be further refined and enhanced. First, the tools' capabilities for meeting the needs of diverse students should expand to offer culturally relevant content and pedagogy. Text selections should include not only texts in multiple languages but works that include characters that illustrate a diversity of races, ethnicities, socioeconomic statues, gender identities, physical and academic abilities, and

other lived experiences. Curricula should give space and voice to each students' lived experiences, cultural competences, and sociopolitical consciousness (Ladson-Billings, 1995). Second, the tools need to increase their capacity for accurately assessing students' abilities and needs, particularly if those abilities are outside of the norm. Benchmarking students' abilities based on nationally normed measures is not always effective. Measurements that are flexible and multifaceted and can take into account such issues as asynchronous development are vital for accurate benchmarking and formative and summative assessments. Finally, following the philosophies of critical technology theory and the requirements of the Americans with Disabilities Act, personalized technology tools and the teachers and administrators who assign them must ensure that all users can equally access them, from features and functionalities within the system to training on the tools and access to the hardware, software, and infrastructure that the tools require.

In my final interview with Alexandra Spichtig at Reading Plus, she said she had noted my story about Annabelle's experience with Kafka from our initial conversation and is working to make changes to Reading Plus to find age- and content-appropriate texts for above-level readers. We discussed the specific difficulties of providing challenging and interesting content for readers who have above-level vocabulary knowledge and reading speeds but age-appropriate understanding and preferences. "You want to make sure the text doesn't become so complicated that they start to fail…especially if you have high achievers that are really pushing themselves already. You'll want to make sure that you don't get to a point where they start failing and start actually losing confidence" (Alexandra Spichtig, personal correspondence, January 26, 2020). The willingness of Spichtig and Reading Plus to address this issue, which is present in only a small percentage of their users, is an important step for the product and its above-level users and

an exciting example of a company taking steps to acknowledge and respond to the red arrows of my final illustration—the myriad influences that shape the experiences, preferences, and views of the students who use the technology. This step is vital in the successful creation and implementation of personalized learning tools and technology as they proliferate through the educational system.

Recommendations

The key recommendation I came to from this research is that educators, teachers, and curriculum and instructional technology developers should make it a priority to assume and find difference rather than focusing efforts on generalizing and grouping when selecting and implementing technology tools into the educational space. The student population is growing in diversity in all areas—birthplace and home language, culture, gender, race and ethnicity, educational experience, socioeconomic status, and other factors. My illustrations represent only a small scale and sample of the influences and factors that we need to understand and take into account in selecting and using educational technology tools. Those who build tools for and work with students must understand that differences exist in students' outlooks, experiences, preferences, aptitudes, and abilities. Furthermore, all educators and administrators who select technology or use it with students must question the publishers and other technology companies about exactly which learner needs their products are designed to address. As illustrated in this study, one size does not fit all.

When considering the selection and implementation of technology tools, educators, administrators, and curriculum and content developers must look at how students do the following:

- Approach content, exercises, and assessments

- Choose their educational experiences, whether that may be the platform they work with, the content they prefer, or the method of engagement and assessments that are used
- Understand the concepts, content, and processes of their educational experience
- Use the tools, features, functions, and materials presented to them
- Live the educational experience: is it stressful? invigorating? nerve-wracking? intriguing? What features and facets affect the user experience, and how? What motivates, demotivates, inspires, and frustrates the students?

Using that data, educators and administrators should keep in mind why they are choosing technology for the students—what benefits will using the technology have? What will the changes and impacts be on the students? What are the goals and expected outcomes for using the technology, and how will the teachers measure success? Leu et al. (2017) recommend that educators and researchers focus on what is needed for students to acquire new literacies, examining the essential social practices, skills, strategies, and dispositions and supporting the development of new literacies within real and virtual learning contexts.

A second recommendation echoes Selwyn's (2015) call to the field of research to look further into the impacts of technology on education, as more money is invested in the creation and adoption of it in the K-12 market. The authors argue that researchers need to study more deeply the motivations, methods, and research that underpin the development of technology tools and examine the impact of new technology at the individual, district, state, and global levels.

Selwyn (2011) decries that academic research is failing to adequately address the social, political, economic, and cultural complexities of technology within education, focusing instead on evaluations aimed at optimization of efficiency rather than problematization of technology

within social contexts and phenomena. He warns us to remain aware of "the values and ideological assumptions that often underpin the extravagant claims made about the potential of digital technology to 'transform' learning or knowledge… it is important to recognize the contested nature of any claims made for technology and learning" (p. 89). This advice draws on both the general skepticism from critics of instructional technology as well as the views of theorists who look at the myriad impacts on the efficacy and impact of technology, as shown in my fourth illustration.

Recommendations for Future Research

There are several areas of the study that would benefit from future research. First, it would be helpful to repeat this study with a broader and more diverse sample to look at how the experiences of using technology are affected by such factors as socioeconomic status, unequal access to and training on technology, differing educational background,s special academic needs, and being an English language learner, to cite just a few examples of student diversity. The simplistic definition used for giftedness in this study—academic success as measured by standard intelligence tests—is an example of a generalization that is limiting and potentially damaging to those students who do not fit into the standard group. Variations within the gifted community could include the inclusion of students with reading challenges, as asynchronous development in gifted students is common; how would such a difference in abilities affect the students' confidence and performance? Examining the experiences of a more diverse group of students would help provide a more thorough picture of how technology can be most effectively built, selected, and implemented.

Second, it would be helpful to examine the role and impact of teachers within the intersection of instructional technology, reading, and gifted education. Though much research

exists on teachers' beliefs about technology and their uses of it in the classroom (see, for example, Blackwell et al., 2014; Blackwell et al., 2016; Crossley & McNamara, 2017; Johnson et al., 2017; Leu et al., 2014; and McDermott & Gormley, 2015), there is little on the specific roles of teachers within reading instruction and gifted education. As this study illustrates, teachers play an important role in choosing and assigning content; for example, in this study the students' desires for creativity could have been addressed through the teachers' inclusion of the writing component of Reading Plus in their lessons, and the students' feeling that the text and vocabulary were too easy for them could have been addressed by the teachers' manual adjustments of the difficulty levels of the text and vocabulary and the speed of the reading pace, which the software allows.

Finally, there are three unexpected findings from this study that merit more investigation. The first is the finding that the students distrust technology. Several students noted that e-books can be manipulated and were not necessarily the authors' original texts, two students mentioned the danger of having confidential information stolen online, and several students felt that Reading Plus was trying to trick them by supplying made-up vocabulary words and incorrect answers to the comprehension questions. A question that calls for further study is, where is this distrust originating? Part of their caution likely comes from the technology instruction at school; the students are trained starting in early elementary grades to be careful about online safety and in later elementary grades to be aware of fake news and other untrustworthy information online. Other sources of the distrust could come from news stories, social media stories, and the students' families; at this grade and age, several students mentioned that they relied on their parents' guidance for finding texts online.

A second unusual finding in this study is that most of the students had a sense that their teachers would be angry with them for incorrectly answering an exercise or assessment. These students preferred to have the computer programs evaluate them because the students found the computer programs to be nonjudgmental and unemotional, in contrast to the teachers. I found this response quite surprising in the specific setting of their school, knowing their teachers and having observed in those classes. The students in my study were academically successful and high-performing, and they appeared not to have any behavioral challenges that might cause them to be disciplined by the teachers, who were themselves very kind and patient with the students. Why, then, did the students have a sense of, and deep concern about, teachers' anger towards them? My hypothesis is that those concerns are linked to the high pressure and extrinsic motivation that they talked about at other points in the interviews—their concerns about getting good grades so their parents would not get made at them and so that they would be successful in school and their future careers. Perhaps this sense of pressure and motivation translated into a concern about their failure and resulting disapproval by their parents or teachers.

The third unexpected finding is closely related to the second: many students in the study cited strong extrinsic motivation in addition to intrinsic motivation. The topic of intrinsic motivation is highly researched in gifted education (e.g. Clinkenbeard, 2012; Dai et al, 1998), but there is little research about the pressure from peers, family, and educational settings on gifted students and the resulting impact on students' extrinsic motivation. The students in the study all cited external pressures and motivation as a key incentive for working hard and seeking academic success. The importance and weight of external pressures and extrinsic motivation deserve a more thorough and careful examination, as they have been understudied in the research to date.

These areas of research on the topic, taken together, would provide a more detailed picture of how and why the students reacted to and interacted with technology in the ways that they did. This broader view of the impacts and uses of technology could in turn provide educators, administrators, and technology developers with a more nuanced and complex understanding of how they should develop, choose, and implement technology tools for the classroom.

Conclusion: An Unexpected Urgency and Relevance to Online Learning

In March 2020, the nation's educational system faced an unprecedented challenge. In an effort to forestall the spread of the pandemic viral outbreak of COVID-19, PreK-12 schools, colleges, and universities announced that they were closing their physical classrooms, sending their students home, and offering their courses online. The U.S. educational system abruptly found itself navigating the myriad challenges of implementing instructional technology tools for millions of students, educators, and administrators with little advanced notice, no formal training, and in many cases insufficient software, hardware, and infrastructure. In a discussion of the challenges faced at the university level, *The New York Times* summarized the concern of students' online access that is a cornerstone of critical technology theory. Though specifically referencing university students, these concerns are universally relevant to students from PreK through university:

> Undergraduates at places like Harvard, Stanford and M.I.T. will largely have no problem getting online to complete their work. But one recent study found that roughly 20 percent of students have trouble with basic technology needs. Their data plans are capped, their computers break, or their connections fail. Those with technology challenges are

disproportionately low-income and students of color, who are also more vulnerable to dropping out (Carey, 2020).

Suddenly, the questions and themes of this dissertation urgently feel relevant. The crisis facing the world's education system moved beyond the challenges of the voluntary and planned adoption of personalized learning. The enormous struggles educators and administrators faced as they worked to implement instructional technology systems for millions of students in highly diverse settings highlighted the inequalities, deficiencies, and misconceptions that exist in personalized learning. Having learning management systems, high-speed internet, and a wide variety of content, tools, and assessments online in place before the pandemic made it possible for some educational systems to attempt to pivot within a few weeks to transition to online learning for their students. Annabelle's school had a robust learning management system in place and was able to take the entire school online within two weeks, but with mixed results as the system repeatedly crashed because of heavy usage and as teachers struggled with the myriad challenges associated with a sudden transition to a fully online learning experience. But many other students, schools, and districts did not have the tools, training, funding, and infrastructure that Annabelle's school did. A survey by Education Week found that 41% percent of school principal and district leaders surveyed said they could not provide remote or e-learning activities to every student in their district "for even one day" (Rauf, 2020).

The Philadelphia school district, where the majority of the 200,000 students were of lower socioeconomic status, announced that many of their students did not have high-speed internet and/or computers that were needed to do online learning, so they would not offer online learning opportunities to anyone in the district (Associated Press, 2020). Instead, students were sent home with learning packets, and teachers were told that they were allowed to check in on

students at home but not offer instruction. Within a week, however, the superintendent reversed that decision and began distributing digital devices and mobile hot-spots and offering supplemental, nonmandatory online learning materials (Herold, 2020). The Chicago Public School district, which serves 355,000 students in 642 schools and is the nation's third-largest school district, similarly initially announced that the district would not offer online learning because they could not provide equal access and opportunities to all of the district's students. Shortly after that decision, however, the Illinois State Board of Education announced that districts in the state had five days to convert all future days of suspended in-person instruction to remote learning days, though they acknowledged that "Given the reality of the digital divide, most schools may need to provide digital and nondigital access to content" (Remote learning recommendations during COVID-19 emergency, 2020). The Chicago Public School district scrambled to provide more than 100,000 devices to its students, including Chromebooks, iPads, and laptops (Mayor Lightfoot announces remote learning opportunities for students at Chicago Public Schools and City Colleges of Chicago, 2020), but faced many challenges in relation to students having adequate supplies, high-speed internet access, training, and access.

As the online education experiment rolled out, the impact of unequal accessibility became starkly clear. While reports from selective schools using online learning in affluent districts show nearly 100% attendance, absentee rates for online learning in schools with large populations of low-income students and in rural areas plummeted to an attendance rate of between one-quarter and one-third of the students due to a lack of hardware, internet access, and economic and health impacts. The difference in instructional time and interactions between the groups will exacerbate an achievement gap that already exists between affluent districts and those with students of lower socioeconomic status (Goldstein et al., 2020).

The impact of the COVID-19 crisis on the educational system has underscored the power and potential of instructional technology in schools as well as its inequalities, weaknesses, and challenges. Technology offers expansive opportunities for students who are able to access it, but those without technology are left behind. Technology is pervasive but not omnipresent, resulting in an inequality of access and opportunities. It can provide complex and sophisticated analyses and recommendations, but it is not omniscient, falling short in areas in which its logic cannot take into account the myriad unique abilities, requirements, and preferences of students. As a result, it is the obligation of every person and entity involved with instructional technology and personalized learning tools to strive to widen their views, understandings, and assumptions about the technology and its users, to understand its impacts and importance in educational settings, and to make decisions about the selection and implementation of technology using the widest samples and sources of data possible.

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Appendix A

Student Survey #1 Script

Hello! Thank you for agreeing to participate in my research.

The first thing I'd like you to do is take this survey, which will ask you some questions about technology, including technology that you like and dislike, and how often you use it. There are no right or wrong answers; I am just interested in your opinions and feelings about technology.

When I use the term "technology," I'm referring to four general types of things:

1. digital devices, like computers, iPads, laptops, and gaming consoles
2. programs, software, websites, apps and games on those devices, like Reading Plus, Google, or Quizlet
3. streaming media and social media sites and apps, like YouTube or Facebook
4. e-books and other forms of digital content

If you have any questions you can stop and ask me. If you don't want to answer a question, you can skip it. Ready? Let's get started.

1. What is your name?
2. How many years have you been at [this school] (including this year)?
3. What are three words you would use to describe how you feel about using technology?
4. How comfortable do you feel when you use technology (circle one)
    - Extremely comfortable
    - Somewhat comfortable
    - Neither comfortable nor uncomfortable

- Somewhat uncomfortable
- Extremely uncomfortable

5. Overall, how much do you enjoy using technology? (circle one)
    - A large amount
    - A lot
    - A medium amount
    - A little
    - Not at all
6. What technology do you have at home? (Check all that apply)
    - Laptop computer
    - Desktop computer
    - iPad or tablet
    - Phone
    - Ebook reader (Kindle, etc.)
    - Video game console (Nintendo Switch, Playstation, XBox, etc.)
    - Other; please give an example
7. What are some of your favorite technology features or programs that you use at school? This includes websites, apps, games, or other programs.
8. Do you play video games? If no, skip to question #12
    - Yes
    - No
9. Which video games do you play? (Give up to five examples.)

10. Are they role-player games? (A role-player game is a game where you are a fictional character that undertakes a quest in an imaginary world.)
    - Yes
    - No
    - I'm not sure
11. Are they multi-player games?
    - Yes
    - No
    - I'm not sure
12. What formats do you read text (for school or fun) in? Check all that apply.
    - Print books
    - Print magazines
    - Ebook reader (Kindle, etc.)
    - Computer (desktop or laptop)
    - iPad
    - Other (please specify)
13. What format do you prefer to read in? (circle one)
    - Print books or magazines
    - On a computer or laptop
    - On an e-book reader (Kindle, etc.)
    - No preference

Appendix B

Student Interview #1 Script

Do you like to work with computers (scale of 1-5; (1 = Not at All; 2 = Not very much 3 = Neither like nor dislike 4 = Like a little bit 5 = Strongly like))? Why/why not?

What programs do you like to work with, and why?

Do you think using technology changes the way you learn things? [Better/worse? Different?]

What are some challenges or problems using technology in school?

Do you like reading? (scale of 1-5; (1 = Not at All; 2 = Not very much 3 = Neither like nor dislike 4 = Like a little bit 5 = Strongly like)

Are there types of books you prefer? (fiction, non-fiction, graphic novels, genres)

How do you feel about having to read for school?

Does the format of what you're reading matter? (magazine, newspaper, book, tablet)

Do you have a preference for reading things on the computer and reading on paper?

How do you decide how you'd like to read something? (on a computer, book, etc.)

What would you rather read on the computer, if anything?

Is reading a book or story different on a computer than on print?

Appendix C

Student interview #2 Script

What was the last thing you read on RP? Tell me about what you read.

Do you think that it was too easy, too hard, or just right?

Did you find it interesting?

How did you decide to select it?

Tell me about the last test you took on RP. [Did you have to guess on any of them? Was it hard? easy? Do you guess on the questions a lot?]

Tell me about using the product. [open-ended; expecting "I like it when…." "I don't like…"] Was it easy when you first used it? What do you like/don't like about it? Interesting/least interesting?

How interesting/engaging did you find the stories in Reading Plus? Are they on topics that interested you?

Are you able to choose story or topics that are interesting to you?

Did you want to read more on that topic, or on other topics? Is having options good?

Are there features that you would like to spend more time on? Less time on?

Are you interested in earning extra profile pictures and backgrounds on Reading Plus? [Confirm what options are]

Would you rather take tests on the computer instead of on paper?

Do you think that you do better on the tests on computer or paper?

Tell me how you read—word by word or skipping around on the page, skip lines, read ahead and double back?

Appendix D

Student Interview #3

If you didn't have to take tests, how would you show what you know?

What is your favorite class at school? Why?

What do you think your strongest subject is? What is your weakest?

Not asking for specific grades, how well do you think you do in language arts?

Do you think that the tests and assignments accurately and fairly test how much you know in language arts?

Do you feel that you work hard in LA? In general and compared to other classes?

What is the main reason that you work as hard as you do?

Do you feel you have enough choices in the work you do on Reading Plus?

Do you feel like you have enough control over what you do in Reading Plus?

How do you feel when you find an assignment at school difficult?

Do you think your grades at school are based more on effort, how much you improve, or if you meet certain goals? Which way of grading do you think is most accurate? Most fair?

Appendix E

Student Interview #4 Script

How do you learn? What do you think is most effective way for you to learn? Most fun? Least effective? Least fun?

Do you think of yourself as competitive? At games? In sports? At school?

Are you more motivated by goals that you set for yourself, assignments from your teachers, or your parents' requests or instructions?

How confident do you feel at school? In LA? Using Reading Plus?

How important is it to you to feel confident in what you're doing?

How often are you bored at school? In LA? What kinds of activities or assignments are more/less interesting? More/less boring?

How do you react when an assignment is boring? Does it make you want to work harder, less, or the same as other assignments?

Do you find the assignments and projects at school to be challenging? How would you define "challenging"?

How do you feel about learning with technology?

Do you think school is a better place/more fun place because you have technology?

Do you think you learn better because you are using technology?

Do you try harder, less hard, or about the same when you're using technology?

Do you feel more or less creative when you're using technology?

Would you be more interested in doing an assignment on your Chromebook if it were like a game or if it allowed you lots of creative control (letting you change the assignment and make up the rules)?

Would you be more motivated to work on Reading Plus if there were rewards? What kind of rewards?

Do you thinking learning to read is valuable? Why?

Would you like to be able to compete with your classmates or other students on parts of Reading Plus? For example, how many questions you can get right, or how many stories you have to read to get a combo, or how quickly you get to your goal reading speed?

When you're reading on RP, who's smarter: you or RP?

Does Reading Plus feel like a challenge you need to overcome or a competition? Or just an assignment?

Are you smarter than Reading Plus? OR are they as smart/smarter than you/not as smart?

Does Reading Plus make you want to read more, less, or the same? (not necessarily on RP)

Do you feel like you have more control and ability to make decisions with Reading Plus or your other LA assignments?

Would you rather work on LA assignments by yourself, just with the teacher, in small groups, or in a whole group?

Would you rather work with the teacher or on Reading Plus?

Would you like Reading Plus to give you more explanation about stories that are hard?

Would you like to spend more time reading or creating in Language Arts? In Reading Plus?

Appendix F

Academic Self-Perception Subscale (Derived from the School Attitudes Assessment Survey (McCoach, 2002)

Please rate how strongly you agree or disagree with the following statements. In answering each question, use a range from **(1)** to **(7)** where **(7)** stands for **strongly agree** and **(1)** stands for **strongly disagree.** Please circle only one response choice per question.

Statement	Strongly Disagree	Disagree	Slightly Disagree	Neither agree nor Disagree	Slightly Agree	Agree	Strongly Agree
1. I am confident in my scholastic abilities.	1	2	3	4	5	6	7
2. I do well in school.	1	2	3	4	5	6	7
3. I learn new concepts quickly.	1	2	3	4	5	6	7
4. I am successful.	1	2	3	4	5	6	7
5. I am confident in my ability to succeed in school.	1	2	3	4	5	6	7

Appendix G

Observation Protocol

What is the student's body language?

- How do they sit (upright, slouching)?
- How attentive/distracted are they?
- Do they seem to be enjoying themselves?
- Are they engaged/absorbed in the exercises?
- Do they seem nervous?
- Are they frustrated?
- Do they seem confident in their answers and choices?

Do they use any badges, avatars, other motivational components of the product?

How did they select a story?

How often do they pause?

How quickly do they work?